1. Continuous Spectrum with Fraunhofer's lines; 2, Spectrum of Sodium; 3, Do. of Potassium; 4. Do. of Strontium; 5, Absorption Spectrum of Arterial blood, diluted 1 in 250; 6, Do. diluted 1 in 400; 7, Same as No. 6 but deprived of Oxygen; 8, Absorption Spectrum of Chlorophyll in Alcohol.

THE

NEW POPULAR EDUCATOR

A Complete Encyclopædia

OF

ELEMENTARY AND ADVANCED EDUCATION

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CASSELL'S

NEW POPULAR EDUCATOR.

CHEMISTRY.—IV.

[Continued from Vol. III., p. [illegible].]

WATER: COMPOSITION—MOLECULE OF ALL GASES AND VAPOURS = 2 VOLUMES—THE FORMULA OF WATER—ICE AND STEAM—RIVER WATER—FILTRATION OF WATER—DISTILLED WATER—WATER AS A SOLVENT—LATENT HEAT—HARDNESS OF WATER.

We have already seen that when hydrogen burns in air or oxygen, water is produced. We have now to show in what *proportions* oxygen unites with hydrogen to form water. The problem is complicated by the fact that the product of the combination, under ordinary circumstances, condenses immediately to a liquid; the relations between water and its constituent elements would be more readily perceived if we could prevent this condensation. This object is attained in an experiment devised by Professor Hofmann.

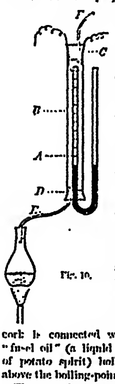


Fig. 10.

A bent glass tube, having one limb closed and graduated, has its closed limb A surrounded by a second glass tube B, the ends of which are closed by two corks C and D (*see* Fig. 10). Two glass tubes E and F are fitted into these corks, the one E passing through the lower cork is connected with a flask which contains "fusel oil" (a liquid obtained in the manufacture of potato spirit) boiling at 132° Cent., *i.e.*, 32° above the boiling-point of water.

The experiment is conducted as follows:—The bent tube is filled with mercury, and a mixture of two volumes of H with one volume of O introduced into the graduated limb A. The fusel oil is then made to boil briskly; the vapour passing up through the tube E surrounds the mixture of H and O in the tube A, and raises its temperature far above the boiling-point of water. The vapour is allowed to pass until the gases in A cease to expand. The open end of the bent tube is then firmly closed with the finger and an electrical spark from a Leyden jar or induction coil passed through the mixture of two volumes of H with one volume of O, by means of two platinum wires which are fused into the upper portion of the limb A, their ends almost meeting in the inside of the tube, as shown in Fig. 11. The sparks passing between the ends of these wires determine the explosion of the mixture, but as the temperature is above 100° Cent., the product remains as an invisible gas which occupies two volumes. In other words, two volumes of hydrogen have united with one volume of oxygen to form two volumes of steam. This can be represented graphically thus:—

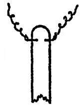


Fig. 11.

$$\boxed{H}\ \boxed{H} + \boxed{O} = \boxed{H_2O\quad}$$

We may remark here that the *molecules* of all gases and vapours occupy two volumes, (*i.e.*, twice as much space as that occupied by an atom of hydrogen). Now, as the formula of a substance enables us to calculate the weight of its molecule, and from the above statement we know that this weight occupies two volumes, we can obviously determine its specific gravity.

Thus steam:—Its formula is H_2O, atomic weight of H = 1; atomic weight of O = 16—

$$\begin{array}{rr} 2H = & 2 \\ O = & 16 \\ \hline & 18 \end{array}$$

The molecular weight of steam is therefore 18,

N.B.—The answers to the exercises in each series of lessons will be found at the end of the lesson following that in which the exercises are set.

COLOURED PLATES AND MAPS.

rise in the inverted tubes; after a short time it will be seen that the gas liberated by the positive is about half the quantity liberated by the negative electrode. The smaller quantity of gas is found to be oxygen, and the larger hydrogen: since oxygen is perceptibly more soluble in water than hydrogen, the volumes are not accurately as 1 to 2. As oxygen is liberated at the positive electrode, it is termed an electro-negative element; hydrogen is similarly called electro-positive.

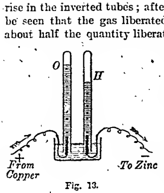


Fig. 13.

Water is a colourless liquid, its formula is H_2O, it solidifies at 0° Cent. or 32° Fahr., and boils, at a pressure of 30 inches of mercury, at 100° Cent. or 212° Fahr.

Steam is a colourless invisible gas; what is popularly called steam, *e.g.*, the white cloud which comes from a locomotive, is not true steam, but a fine dense mist; in other words, a collection of very small particles of condensed water.

The specific gravity of ice is 0·917, water = 1·0, and accordingly ice floats on water. This is an exception to the general rule that bodies when they solidify become heavier than the liquids from which they are formed. If this were the case with water, the ice would sink to the bottom as fast as it was formed, and during a severe winter even deep rivers and lakes would be frozen into a solid mass of ice, from below upwards.

Water is about 825 times heavier than air. One gallon of water weighs 10 lb., and a pint $1\frac{1}{4}$ lb; a cubic foot of water weighs very nearly 1,000 oz. avoirdupois; one cubic centimetre of water at 4° Cent. weighs one gramme.

Steam is much lighter than air. Its specific gravity is 0·625 (air = 1).

Water is of immense use to man, it furnishes him with his cheapest means of transit, and the enormous share which it has had in sculpturing the earth's surface has already been discussed in the lessons on Geology.

The purest form of water which exists in nature is rain-water, and even this always contains a little oxygen, nitrogen, and some ammonium nitrate; in large towns, rain-water contains, in addition, much carbonaceous matter and some sulphates, owing to the products of combustion of coal and gas.

The composition of river-water depends to a great extent upon the nature of the river-bed. If the river flows over a granite district, the water dissolves but little; if it passes through a peaty district, enough organic matter may be dissolved to render the water reddish-brown; and after passing over chalk, the water holds in solution a considerable quantity of lime salts. River-water also contains ordinary salt (NaCl), nitrates, ammonium salts, gases (O, N, and CO_2), and organic matter, vegetable and animal. When water contains substances which give to it a medicinal action, it is called a mineral water or spring. If it contains iron, we have a chalybeate spring, sulphuretted hydrogen, a sulphur spring, etc. Such springs may contain magnesium sulphate (Epsom salts), sodium sulphate (Glauber's salts), silica, as in the geyser springs of Iceland, carbonic acid, etc. Sea-water owes its peculiarities to the relatively large quantity (three to four parts in the hundred) of saline matter which it contains, the bulk being ordinary salt (NaCl). In certain inland lakes, as the Dead Sea, the water contains a still larger amount of mineral matter.

Water is usually purified for drinking purposes by filtration; the filter-beds on the large scale are usually composed of clean gravel and sand, on the small scale of blocks of carbon, sponge, etc. The action of an efficient filter is twofold—it strains off any solid impurities, and in addition it burns up or oxidises a considerable portion of the organic impurity in the water. This is effected by the oxygen in the air which is held mechanically by the porous bed; this oxygen being brought into intimate contact with the organic matter as it passes through the filter, combines with it, and converts it into carbonic acid and water. The same action should take place in the domestic filter, but in many cases the filter seems to be regarded as an automatic charm—the water has only to be poured in and is sure to come out pure. Now unless a filter is properly cleansed periodically, and allowed to dry, so that it can absorb a fresh quantity of oxygen, it may serve simply to accumulate all the impurities from all the water which passes through, and it may ultimately become worse than useless, and the water which is drawn from the filter may be less pure than the ordinary tap-water.

In order to obtain pure water for chemical purposes, ordinary river-water must be distilled, *i.e.*, boiled, and the steam condensed in a tube made of glass or pure tin (not the tin-plate used for saucepans, etc., which is iron covered with tin) surrounded with cold water; this condensing tube is usually coiled up, so that a considerable length may be contained in a small space (Fig. 14). The first portion of water which distils over should be thrown away, and the distillation should never be continued

and this weight occupies two volumes, so the weight of one volume, *i.e.*, its specific gravity, $= \frac{18}{2} = 9$, hydrogen being taken as 1.

The *molecular* weight of oxygen is 32; and its specific gravity $= \frac{32}{2} = 16$.

The formula of alcohol is C_2H_6O, atomic weight of $C = 12$—

$$\begin{array}{r} 2C = 24 \\ 6H = 6 \\ O = 16 \\ \hline 46 \end{array}$$

$\frac{46}{2} = 23$ = specific gravity of alcohol vapour. In other words, a given volume of alcohol vapour weighs 23 times as much as the same volume of hydrogen.

We have seen by Hofmann's experiment that two volumes of steam contain two volumes of hydrogen united with one volume of oxygen, the three volumes being condensed to two.

The second method by which the composition of water has been determined with great accuracy gives us the *weight* of oxygen combined with one part of hydrogen. This experiment was performed by Dumas in 1843. It consists, essentially, in passing hydrogen, which is purified and dried with every conceivable care, over a small quantity of heated black oxide of copper, contained in a light two-necked globe of glass, Fig. 12. The reaction which occurs is represented by the following equation:—

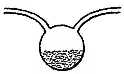


Fig. 12.

$$\underbrace{CuO}_{\text{Black oxide of copper.}} + 2H = \underbrace{Cu}_{\text{Metallic copper.}} + H_2O$$

Water is formed, and the black oxide converted into metallic copper. The water is collected with great care and weighed. The hydrogen is allowed to pass for some hours, the stream of gas is then stopped, and the apparatus allowed to cool. The bulb with the oxide of copper is accurately weighed before and after the experiment, its loss in weight gives the amount of oxygen which has passed off in combination with the hydrogen, and this weight of oxygen deducted from the weight of water formed gives us the hydrogen. As a mean of nineteen very careful experiments, Dumas found that 7·98 parts of oxygen combined with 1 part of hydrogen.

Some 25 years ago the formula of water was written HO, and the atomic weight of oxygen was 8; this agrees just as well with the results of Dumas as the present formula H_2O, taking atomic weight of $O = 16$.

It will be instructive to consider one of the reasons why the formula of water was changed to H_2O, and the atomic weight of oxygen to 16.

If we add a piece of potassium to water, we get the following reaction, which we have already studied under Hydrogen:—

$$K + H_2O = KHO + H.$$

One atom of potassium replacing one atom of hydrogen in the water, forming potassium hydrate (KHO); this substance still contains hydrogen, but if we take some solid KHO and heat it with potassium, the last atom of hydrogen is expelled and potassium oxide formed—

$$KHO + K = K_2O + H.$$

It is clear that in these decompositions the hydrogen has been taken out from the water in two separate pieces, one coming out in the first, and the other in the second reaction. By our definition, an atom is the *smallest* quantity of an element which can exist, we cannot therefore divide an atom, and as the hydrogen in water is divisible into two pieces or atoms there must be at least two atoms of H in the molecule of water. The formula of water is therefore written H_2O, and the atomic weight of oxygen was altered to 16 in order to keep the ratio of the hydrogen to the oxygen in water 1 to 8 or 2 to 16.

Another method of proving that water contains two volumes of hydrogen to one volume of oxygen is to decompose water, acidulated with sulphuric acid, by means of a current of electricity. A galvanic or voltaic cell consists of a plate or rod of zinc and a plate of some other substance, which is usually either copper, platinum, or carbon; the two plates being immersed in some fluid which can dissolve the zinc, but does not act on the other plate. A copper wire is attached to the zinc plate, the end of this wire is called the negative pole, negative electrode, or sometimes the kathode; the end of a similar copper wire from the copper, platinum, or carbon plate is termed the positive pole or electrode, or sometimes the anode. The current of electricity is usually said to flow, *outside* the cell, from the positive or copper end to the negative or zinc end of the battery. A series of two or more galvanic cells joined together in a suitable way is called a "battery."

The current from a battery of five cells is passed through water acidulated with sulphuric acid by means of two platinum plates fixed to the two battery wires. Two graduated tubes are filled with acidulated water and inverted over the platinum plates (Fig. 13); as soon as the current passes, minute bubbles of gas will collect on the platinum plates, and eventually

$$\underset{\text{Soap.}}{\text{Sodium stearate}} + \text{Calcium chloride}$$

$$= \underset{\text{Lime soap.}}{\text{Calcium stearate}} + \underset{\text{Salt.}}{\text{Sodium chloride.}}$$

A lime soap and salt are formed. The lime soap is insoluble in water, it is therefore useless for cleansing purposes, and floats as a curd in the basin. As long as any soluble salt of calcium or magnesium exists in the water, all the soap introduced is decomposed and converted into an insoluble form.

The hardness of water is said to be "temporary" and "permanent." Temporary hardness is destroyed by boiling; it is due to one particular calcium salt, the calcium bicarbonate, $\left\{\begin{matrix} CaCO_3 \\ H_2CO_3. \end{matrix}\right.$ This calcium salt is soluble in water, and is formed whenever water containing carbonic acid comes in contact with chalk ($CaCO_3$). Thus all rivers which flow over chalky beds have temporary hardness. If a solution of this calcium bicarbonate be boiled it decomposes—

$$\left.\begin{matrix} CaCO_3 \\ H_2CO_3 \end{matrix}\right\} = \underset{\text{Chalk.}}{CaCO_3} + H_2O + CO_2$$

The chalk is precipitated, and the carbonic acid escapes. It is this decomposition which causes the deposit or "fur" in our boilers and kettles. In marine boilers the deposit consists largely of calcium sulphate. Dr. Clark devised a process for getting rid of this temporary hardness. He adds to the water a *certain quantity* of ordinary slaked lime $Ca(HO)_2$, and after thorough mixing, allows the water to stand until it is clear, when it is drawn off for use. The reaction is—

$$\left.\begin{matrix} CaCO_3 \\ H_2CO_3 \end{matrix}\right\} + Ca(HO)_2 = 2CaCO_3 + 2H_2O,$$

and we see that if we add the *proper quantity* of slaked lime, the calcium dissolved as bicarbonate and the lime which we add are both precipitated as chalk ($CaCO_3$), and thus the whole of the temporary hardness of water can be removed. Permanent hardness cannot be removed by boiling, and is caused by calcium salts, other than the bicarbonate, as calcium chloride, calcium sulphate, etc.

For washing purposes, water can be effectually softened by adding a very small quantity of sodium or ammonium carbonate, either of which substances will precipitate the whole of the calcium as carbonate, and render the water much more pleasant to wash in.

Ordinary Thames water contains calcium salts equivalent to 15 grains of chalk in the gallon; if one ounce of ordinary washing soda be dissolved in $\frac{1}{2}$ pint of rain-water, $\frac{1}{10}$th of this solution will be sufficient to soften a gallon of Thames water.

GERMAN.—XIX.

[*Continued from Vol. III., p. 328.*]

VARIOUS IDIOMS.

Pflegen, besides its primary meaning "to nurse" or "take care of," has in both the present and imperfect the signification "to be accustomed," "to be wont," as:—Er pflegte zu sagen, he *used* to say; Er pflegt zu reiten, he is *accustomed* to ride (on horseback).

Achten or Acht haben, followed by auf, is used thus:—Ich achte auf das, was ich höre, I give attention to that which I hear; Ich werde Acht auf ihn haben, I will attend to him (have attention on him); Er nimmt sich in Acht, he takes care of himself; Wir müssen uns vor dem Bösen in Acht nehmen, we must guard ourselves against that which is bad (take ourselves in attention before, etc.).

EXAMPLES.

Vor einen falschen Menschen soll man sich mehr in Acht nehmen, als vor einer gif'tigen Schlange.	One should guard oneself more against a treacherous person than against a poisonous serpent.
Er hat mehr Acht auf seine Umge'bung, als auf sich selbst.	He gives more attention to those who surround him than to himself.
Gebet Acht auf lehr'reiche Gesprä'che, und behal'tet das Beste.	Give attention to instructive conversation, and retain the best.
So'crates pflegte zu sagen, er wisse weiter nichts, außer daß er nichts wisse, und so pflegt noch heu'tigen Tages jeder Beschei'dene, und selbst der Geschei'teste zu sagen.	Socrates was accustomed to say he knew nothing farther than that he knew nothing; and so, at the present day, every modest person, yea, even the most learned, is accustomed to say.

VOCABULARY.

Allein', alone, but.
A'meise, *f.* ant, emmet.
Appetit', *m.* appetite.
Christus, *m.* Christ.
Damit', therewith.
Ei'chenhain, *m.* grove of oaks.
Geburt', *f.* birth.
Gesund'heit, *f.* health.
Glatt, smooth.
Gut, *n.* good, gift, blessing.
Hamster, m. German marmot.
Le'bensunterhalt, *m.* subsistence.
Mü'ßiggang, *m.* idleness, sloth.
Opfern, to offer, sacrifice.
Pflegen, to foster.
Regie'rungsantritt, *m.* accession to the government.
Schmeichler, *m.* flatterer.
Selbst'erkenntniß, *f.* self-knowledge.
Sommer, *m.* summer.
Sorgen, to care, to take care.
Tugend, *f.* virtue.
Vor'tragen, to propound, tell.
Winter, *m.* winter.
Wiederher'stellen, to restore.

EXERCISE 110.

Translate into English:—

1. Derjenige, welcher in der Jugend sorgt, braucht nicht im Alter zu sorgen. 2. Habe Acht auf Dich, nicht nur in Gesellschaft fremder Leute, sondern auch wenn Du allein bist, damit Du Dich selbst kennen lernst. 3. Derjenige, welcher nicht immer auf sich Acht giebt, kommt nie zur Selbsterkenntniß. 4. Die alten Deutschen pflegten gewöhnlich in alten Eichenhainen ihren Göttern zu opfern. 5. Gute Kinder pflegen ihre Eltern in ihrem Alter. 6. Meine Freunde pflegen des Morgens Wasser zu trinken. 7. Des Morgens und des Abends pflegt er der Ruhe. 8. Wir pflegen, anstatt des Thees, Kaffee zu trinken. 9. Seiner Gesundheit zu pflegen, ist seine erste Sorge. 10. Er pflegt des Morgens zu arbeiten, und des Nachmittags zu lesen. 11. Derjenige, welcher des Müßigganges pflegt, pflegt auch der Sünde. 12. Pfleget der Tugend, und nicht des Lasters. 13. Er pflegt nicht vor acht Uhr aufzustehen. 14. Man pflegt nicht in Amerika, wie in Deutschland, zu sagen: „Ich wünsche Ihnen einen guten Appetit." 15. Der Mensch sorgt oft mehr als nöthig ist um seinen Lebensunterhalt. 16. Die Ameise sorgt schon im Sommer für ihre Nahrung in Winter. 17. Der deutsche Kaiser Maximilian I. trug gleich bei seinem Regierungsantritt Sorge, die innere Ruhe Deutschlands wiederherzustellen.

EXERCISE 111.

Translate into German:—

1. Guard yourself against those who have smooth words, bad thoughts, and a treacherous heart. 2. He cares more for his soul than for his body. 3. We are accustomed to drink tea instead of coffee. 4. The Greeks fostered art and science long before the birth of Christ. 5. He is accustomed to rise at six o'clock. 6. I will take care of this book till you return. 7. He takes care of his health. 8. Give attention to thyself, not only when you are in society, but also when you are alone. 9. Good children give attention to that which their parents tell them. 10. We must guard ourselves against our enemies. 11. A German marmot takes care in the summer of his food for the winter.

Umhin (around there) is used only in connection with können, as:—Ich konnte nicht umhin, es ihm zu sagen, I could not (get) *around*, *i.e.*, I could not help, or avoid, telling it to him; Ich habe nicht umhin gekonnt, es zu thun, I could not help doing it, I could not but do it.

Spazieren (to take a walk, to take an airing) signifies, in union with gehen, fahren, reiten, führen, "to take a walk," "to take the air in a coach," "to ride out, or take the air on horseback," "to lead about, or on a walk," as:—Eine Stunde des Tages ausgenommen, in welcher er seine Schwester spazieren führt, sitzt er beinahe immer an seinem Schreibtische und studirt, während sein jüngerer Bruder lieber spazieren geht, spazieren reitet, oder in Gesellschaft einiger Freunde spazieren fährt, one hour of the day excepted, in which he takes his sister for a walk, he is almost always sitting at his writing-desk and studying, while his younger brother prefers to go for a walk, to ride on horseback, or to take a drive in company with a few friends.

Thun (to do) is in some phrases used impersonally, as:—Es thut nichts, it does *or* effects nothing, *i.e.*, it is no matter; Es thut Noth, it is necessary.

Behüte and bewahre, or Gott behüte, Gott bewahre, are often used, especially in conversation, to denote aversion, abhorrence, fear, etc., and may commonly be rendered, "God forbid."

VOCABULARY.

Arg, bad.
Aus'bildung, *f.* cultivation, education.
Behand'lung, *f.* treatment.
Belei'digen, to offend.
Bemer'ken, to observe.
Bewei'sen, to prove.
Bewer'ben (sich), to sue for.
Blick, *m.* look, glance.
Brüsten (sich), to be proud, to show airs.
Curgast, *m.* guest (under cure).
Danken, to thank.
Entflie'hen, to flee.
Entwen'den, to purloin.
Groß'thun, to boast, brag.
Hin'wenden (sich), to turn to.
Indem', in that, while.
Ita'lien, *n.* Italy.
Kenntniß, *f.* knowledge.
Nie'dersinken, to sink down.
Ohn'mächtig, weak, swooning, fainting.
Panzern, to arm with a coat of mail.
Platte, *f.* plate, crown (top).
Rennthier, *n.* reindeer.
Schlitten, *m.* sledge.
Schnell'igkeit, *f.* rapidity.
Tadel, *m.* blame, censure.
Tau'nusgebirge, *n.* the Taunus mountains, a mountain range near the Rhine.
Umhin'können. (*See* above.)
Unglaub'lich, incredible.
Versa'gen, to refuse.
Vor'sätzlich, intentionally.
Wand, *f.* wall (of a room).
Wenden, to turn.
Wiss'enschaftlich, scientifically.
Zu'bringen, to spend, pass away.
Zu'träglich, advantageous, conducive to.

EXERCISE 112.

Translate into English:—

1. Diejenigen, welche zu viel spazieren gehen, gewöhnen sich endlich an den Müßiggang. 2. Eine halbe Stunde nach dem Essen spazieren gehen ist der Gesundheit sehr zuträglich. 3. In Italien fahren Viele mit Maulthieren spazieren. 4. Man sieht gewöhnlich mehr Herren spazieren gehen, als spazieren reiten. 5. Die Curgäste in Wiesbaden reiten oft auf Maulthieren auf die Platte des Taunusgebirges. 6. Reisen zu Fuß ist oft angenehmer, als zu Wagen oder zu Pferd. 7. Die Lappländer fahren auf Schlitten, und bedienen sich der Rennthiere anstatt der Pferde. 8. Er verwandte beinahe kein Auge von seinen Verwandten, die er in so langer Zeit nicht gesehen hatte, und freute sich ihrer Erzählungen. 9. Für diesen jungen Soldaten

haben sich die meisten Officiere bei dem General verwendet. 10. Ich wandte mich in meiner Noth an meine Freunde; allein, wo ich mich hinwandte, sah ich nur gleichgültige Blicke. 11. Er entwandte mir meine Uhr und einige andere Gegenstände, ohne daß ich es bemerkte. 12. Derjenige, welcher mit seinen Kenntnissen groß thut, beweist damit, daß er weniger weiß, als er sich brüstet und andere glauben machen will. 13. Sie werden doch nicht glauben, daß ich Sie vorsätzlich beleidigt hätte? 14. Gott behüte! ich habe nie so etwas Arges von Ihnen geglaubt und glauben wollen. 15. Sie werden bei diesem schönen Wetter doch nicht zu Hause bleiben wollen? 16. O bewahre, ich habe nicht Lust, einen so schönen Tag zwischen den vier Wänden meiner Stube zuzubringen. 17. Es haben sich mehrere um dieses Amt beworben, und zwar folgende. 18. Ich kann nicht umhin, Ihnen zu sagen, daß mir diese Behandlung nicht gefällt. 19. Ich kann nicht umhin, Ihnen recht herzlich zu danken. 20. Als ich auf den Wolf schießen wollte, versagte * mir die Flinte.

Exercise 113.

Translate into German:—

1. He could not help expressing his censure. 2. Preserve us, O Lord, from sin. 3. I could not help forgiving the wrongs which I had endured. 4. While he said this he sank down fainting. 5. We shall ride slowly to the park. 6. The queen took an airing on horseback yesterday. 7. This merchant boasts of his riches. 8. The Arabian rides on horseback with incredible rapidity. 9. When the knights of olden times rode to war, their horses were armed with a coat of mail. 10. Kings and princes are accustomed to drive with six horses. 11. When he could have escaped, his strength failed him. 12. The wood is used for building. 13. He has devoted the greatest part of his youth to scientific pursuits. 14. Journeys through the Rhine valley are more agreeable on foot than on horseback. 15. John leads his sister about the park, while her father rides on horseback.

Los (loose, apart, etc.), when combined with verbs, has a variety of significations. Its exact force in any given place is best determined by the context, as:—Losbinden, to unbind; losgehen, to break out, to go off; losreißen, to tear asunder; Ein Gewehr losbrennen, to fire (off) a gun; Das Gewehr ist losgegangen, the gun (went off) discharged (accidentally); Der Streit geht wieder los, the contest is beginning again.

Vocabulary.

Auf'merksamkeit, *f.* attention.
Bergen, to lend, to borrow.
Emi'lie *f.* Emily.
Erre'gen, to excite, raise.
Gepäck', *n.* baggage, luggage,
Habe, *f.* property.
Heer, *n.* host, army.
Kalk, *m.* lime.
Los'gehen. (*See* los above.)
Los'werden, to free, disengage oneself.
Möglich, possible.
Spaß. *m.* sport, joke.
Traurig, mournful, sorrowful.
Übrig, over, remaining.
Ü'brigbleiben, to be left, to remain.
Un'beschäftigt, unemployed.
Ziehen, to draw.

* Would not go off, *i.e.*, missed fire

Exercise 114.

Translate into English:—

1. Der Arzt hat mir gerathen, so wenig wie möglich auszugehen. 2. Emilie arbeitet so wenig wie möglich, um die Feinheit ihrer Hände zu erhalten. 3. Die Kinder sollten jeder Zeit so wenig wie möglich unbeschäftigt sein. 4. Er spricht so wenig, um keine Aufmerksamkeit zu erregen. 5. Ferdinand ist jetzt sehr wenig zu Hause. 6. Auf der letzten Reise hatte ich ganz wenig Gepäck bei mir. 7. Wollen Sie etwas Fleisch haben? 8. Ja, aber nur ganz wenig. 9. Es bleibt ihm nichts übrig, als zu betteln, oder zu arbeiten. 10. Es bleibt nicht Anderes übrig, Sie müssen jetzt handeln. 11. Von all seiner Habe blieb ihm nichts übrig, als ein Stück Land. 12. Diese Rose blieb allein von allen Blumen übrig. 13. Er blieb allein von dem ganzen Regimente übrig. 14. Ich kann diese traurigen Gedanken nicht los werden. 15. Um seine falschen Freunde los zu werden, muß man ihnen Geld borgen. 16. Gewähren Sie ihm seine Bitte, damit Sie ihn los werden. 17. Jetzt ging der Spaß von Neuem los. 18. Der Kalk an der Mauer geht los. 19. Als der Krieg wieder losging, zog er mit einem großen Heere in das Feld. 20. Das Gewehr ging los, als er es ergreifen wollte.

Exercise 115.

Translate into German:—

1. The physician advised my sister to stay at home as much as possible. 2. A teacher should always keep his scholars unemployed as little as possible. 3. The orator spoke with great enthusiasm, in order to raise the attention of his auditors. 4. Most travellers take with them as little luggage as possible. 5. Will you have some apples? 6. Thank you, Sir, I have quite enough. 7. Augustus is now very much at home, hence we may go to him. 8. There is nothing left for him but submission to his destiny. 9. I had no other resource left me than to fly from the enemy. 10. Of all his property, nothing was left but a garden. 11. I cannot get rid of my cold. 12. Grant the request of this false friend, then you will get rid of him. 13. Who broke the foot of the table? 14. The servant broke it off when she cleaned the room. 15. Frederick the Great marched at the head of his army to the war. 16. The gun went off accidentally, or he would have shot the hare.

Key to Exercises.

Ex. 104.—1. A spiritual enjoyment is more durable than a sensual one. 2. The avaricious man never obtains so much as he wishes to have. 3. The higher one gets in the upper regions,

the colder it becomes. 4. The more one party hated him, the more the other loved him. 5. The higher Napoleon rose, the more ambitious he became. 6. The adjacent river affords the neighbouring inhabitants many advantages. 7. How much of your property have you lost? 8. I have lost more than half. 9. What day of the month do you set out from here? 10. My departure is fixed for the twelfth of this month. 11. What day of the month will your brother come here? 12. I expected him three days ago. 13. A year ago I was still in Germany. 14. A few years ago the most learned and able men had their residences in Weimar. 15. Iron is more useful than gold and silver, although the value of gold and silver is greater. 16. The whole multitude was of one opinion.

Ex. 105.—1. Ist Ihr Bruder so vorsichtig als Ihr Onkel? 2. Er ist nicht so vorsichtig, als mein Onkel. 3. Nimm, weder mehr noch weniger als die Noth erfordert. 4. Obschon er ein schönes Landgut besitzt, so will ich dennoch einen Theil des meinigen an ihn abtreten. 5. Sie thaten nichts, als sich über ihr letztes Unglück beklagen. 6. Ich sah Niemand in dem Saal, als den blinden Pfeifer. 7. Je länger er bei ihm blieb, desto ungeduldiger wurde er. 8. Den wievielsten wird Ihr Freund von hier abreisen? 9. Seine Abreise ist auf den vierzehnten nächsten Monats festgesetzt. 10. Wir wollen diesen Weg gehen, um die Landschaft in der Nähe zu sehen. 11. Nichts als Fröhlichkeit war in der ganzen Familie. 12. Nur ein Wunsch blieb ihm übrig. 13. Niemand ist unserer Gute so würdig, als der Freund meines Bruders.

Ex. 106.—1. I am nineteen years old, and in my twenty-third year I shall go with my father to England. 2. My eldest brother had invited twenty-five persons, among whom nearly half were married. 3. The company left us at a quarter to twelve. 4. Columbus discovered America in the year 1492. 5. A dozen contains twelve (pieces), and a pound contains thirty half ounces (German measure). 6. We bought three casks of oil, two pairs of shoes, and seven yards of cloth. 7. Thousands of Germans emigrate to America. 8. I have sold a hundred pens for half a dollar. 9. Shakespeare's birthday is the twenty-third of April. 10. Louis the Fourteenth was a lover of the fine arts and sciences. 11. The emperor died at twenty minutes past eleven. 12. I have been only twice in America, but four times in England. 13. The Germans have had war with the French at different times. 14. The numbers four and nine have won threefold. 15. The battle of Waterloo was on the eighteenth of June, 1815. 16. Do you know how old that man is? 17. He is sixty years old. 18. This handsome horse is three years old, and that larger one is six. 19. What wine is this? 20. It is of the vintage of 1834.

Ex. 107.—1. Mein Bruder hat hundert Bücher, und mein Onkel, der Professor, hat mehr als tausend. 2. Er stand gewöhnlich um halb sechs des Morgens auf, und arbeitete bis drei viertel auf elf. 3. Ich habe sieben Monate bei ihm zugebracht. 4. Ich habe zwei Dutzend Federn und sieben Buch Papier verkauft. 5. Die Hälfte eines Hasen aß er zu seinem Frühstück. 6. Dieses schöne Pferd ist fünf Jahre alt. 7. Der dritte Theil dieses Geldes gehört mir. 8. Ich vergab Ihnen einmal. 9. Sie thaten es zweimal. 10. Dieses Stück enthält ungefähr zwei und zwanzig Ellen. 11. Meine Schwester starb in ihrem sechszehnten Jahre. 12. Tausende starben im Jahre 1852 in Polen an der Cholera. 13. Die Flasche zwei und dreißiger (Wein) wird für einen Thaler verkauft. 14. Meine Schwester kaufte drei Ellen Band. 15. Rom wurde von Romulus sieben hundert und zwei und fünfzig Jahre vor Christi Geburt gegründet.

Ex. 108.—1. Even the victors praised the valour of the conquered. 2. The song touched even the most inflexible hearts. 3. The strains of music reached even our ears. 4. Even here the children's joyful laughing can be heard. 5. How can one demand of others what he will not do himself? 6. One ought to esteem himself. 7. The weed grows by itself, without our sowing and attending to it. 8. Even poverty shall not hinder me from acting honestly. 9. If you also forsake me, then I have no longer a friend. 10. Oh, that that time were already arrived! 11. Although he has a rough exterior, nevertheless he has a tender heart. 12. If you do this also, I will reward you well. 13. However many there are of you, I will enter into a contest with each of you. 14. However much Henry works, nevertheless he accomplishes nothing. 15. However much he spoke, nevertheless they did not hear him.

Ex. 109.—1. Was er auch sagen mag, ich werde beharren. 2. Selbst mit diesem Gewinn waren sie nicht zufrieden. 3. Das Unglück dieser Familie war so groß, daß sie sogar fremde Leute um Unterstützung baten. 4. Ich werde selbst mit einer Begleitung nicht abreisen. 5. Der Mond giebt uns nicht so viel Licht, als die Sonne, selbst wenn er am hellsten scheint. 6. Was Ihr Freund auch sein mag, Sie werden es nicht erhalten. 7. Wer dieses junge Fräulein auch sein mag, sie ist sehr unhöflich. 8. So listig sie auch sein mögen, irren sie sich doch zuweilen. 9. So groß auch meine Armuth sein mag, werde ich doch nicht muthlos werden. 10. Was die Neuigkeit auch sein mag, theile sie mir mit.

HISTORIC SKETCHES, ENGLISH.-XIX.

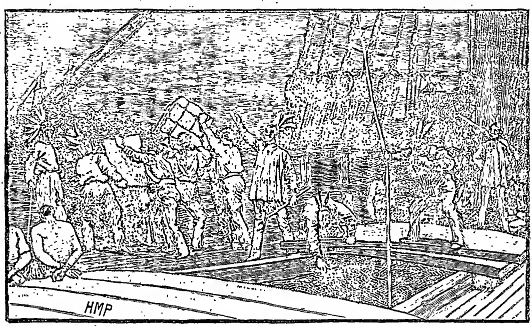
[*Continued from Vol. III., p. 333.*]

ORIGIN OF THE UNITED STATES.

"The gentleman tells us America is obstinate; America is almost in open rebellion. Sir, I rejoice that America has resisted. Three millions of people so dead to all the feelings of liberty as voluntarily to submit to be slaves, would have been fit instruments to make slaves of all the rest. I come not here armed at all points with law cases and Acts of Parliament, with the statute-book doubled down in dog's ears, to defend the cause of liberty. If I had, I myself would have cited the two cases of Chester and Durham. I would have cited them to show that even under arbitrary reigns Parliament were ashamed of taxing a people without their consent, and allowed them representatives. The gentlemen asks, when were the colonies emancipated? But I desire to know when they were made slaves."

Such were the words of Mr. Pitt, on the 14th of January, 1766, in the course of an indignant remonstrance he made against the policy the Government was pursuing towards the British colonies in

America, a policy which was arousing in the colonists a fierce and implacable resentment towards the mother country, and which finally determined them to sever at all risks their connection with her. The occasion was a memorable one, the words used by some orators in the debate were almost pro-



RAID ON THE TEA-SHIPS IN BOSTON HARBOUR.

phetic, and the blindness of the rulers in the matter savoured almost of affliction.

Of all the colonies of Great Britain, none were more loyal, more generous in their devotion, more easily governed, than the plantation colonies in America. Though founded originally by those who preferred to face Nature in her wildest form, both as regards scenery and men, rather than live under the rule of oppressors in their native land, the colonies had become famous for inhabitants of unquestionable loyalty, men whose pride it was to speak of England as their home, who cherished English ways and English modes of thonght, named their towns after their old homes in England, taught their children not only to fear God, but also to honour the king who had never seen their land, and who dwelt in a remote island far across the sea.

Nearly 150 years had elapsed since the Pilgrim Fathers, leaving England in the *Mayflower*, landed near Cape Cod and founded Plymouth, the first of the New England settlements. By conquest, by treaty, by settlement, by purchase, the American colonies grew till they constituted thirteen large provinces, each having a governor appointed by the King of England, with local magistrates, on the municipal system, administering the laws of England and such local laws as were from time to time found to be necessary. At the time Mr. Pitt spoke of them in the English House of Commons they inclnded over two millions of people of European blood, and abont a million more of Africans and native Indians; but these three millions were scattered over a vast tract of country, and might well have been deemed unable to cope with the organised forces of a powerful empire. "I know the valour of your troops, I know the skill of your officers," said Pitt. "In a good cause, on a sound bottom, the force of this country can crush America to atoms. But," he added, "in such a cause as this your success would be hazardous. America, if she fell, would fall like the strong man. She would embrace the pillars of the State, and pull down the Constitntion along with her! Is this your boasted peace? Not to sheathe the sword in its scabbard, but to sheathe it in the bowels of your countrymen?"

But what was the occasion of this language? Of what nature was the fear that the loyal colonies would throw off their allegiance? What cause was there to suppose that the United States were about to come into existence? Were was the vulnerable

place in the dutifulness of the Americans? Let us see.

From the time of the first settlement till 1765 all had gone well with the colonists, because they had been left alone by the Home Government. Beyond sending out governors, and occasionally issuing orders which were necessarily to be obeyed, not only by the American colonies, but by every part of the empire, for the common good, the authorities at Whitehall troubled their heads very little about the "plantations," as they were called. But in 1765 it occurred to Mr. Grenville, then at the head of affairs in England, to recruit the exhausted treasury by extending some of the imposts which were payable in England to the colonies. It must be conceded that if he did not know he was doing right, he was by no means assured he was doing wrong, in resorting to such an expedient, though the arguments which were advanced to him, to say nothing of the question as to the policy or impolicy of the movement, might have had more weight than he chose to allow them. He decided, after trying one or two petty imposts (which, though not acquiesced in, were not resisted), to extend to America the same stamp duties as were payable by the people at home, and he hoped by this means to gather into the imperial coffers a sum estimated at something less than £100,000 a year.

Now one of the most valuable concessions ever made by a king was the concession which was made by King John in the Great Charter, and afterwards ratified in a separate Act of Parliament, to the effect that no money by way of tax, or by any other means, should be levied on the commons of England *without their own consent previously expressed by the voice of their representatives in Parliament.* The American colonies had not any representatives in the English House of Commons, no one by whom they could assent or dissent to the proposals made to tax them, and they could not therefore legally be called upon to obey the orders in such a matter even of the British king, lords, and commons. Already they had put up their backs against some custom-house charge which had been imposed in 1764, though they admitted the abstract right of the imperial Government to charge them, and though the money raised was intended to be spent on the protection and improvement of the colonies. They were taking annually something like the worth of £3,000,000 a year in British produce and manufactures, and with increasing prosperity would have taken much more, when the imposition of these vexatious duties turned the current of their commercial liberality backwards, and resolved them to form societies for the renunciation of trade with Great Britain. It was while things were in this state that Mr. Grenville, "by way of experiment, towards further aid from the Americans," brought into the British House of Commons a Bill to extend to America almost all the stamp duties in force at home.

The American colonists were deeply incensed when they heard that the Bill had passed into law, and that it had done so without a division in the House of Lords, and with only one division in the House of Commons. It was not because they begrudged the money. Had the king chosen to send letters to the Assemblies of each of the provinces, asking for a grant in aid of imperial expenses, especially the expenses incurred in defending the American coasts and frontiers, there cannot be any doubt but the call would have been answered liberally. They would give handsomely if asked to give, but pay as a matter of right they would not. So the colonists determined. Mr. Grenville, though remonstrated with by all who knew most about the colonies, insisted on his Stamp Act; collectors and assessors were appointed, and Boston was chosen as the head-quarters of the Stamp Commissioners.

As soon as the news reached Boston the flags of the shipping there were hoisted half-mast high, and the church bells tolled as if for a funeral, the Stamp Act itself was reprinted and sold, with a death's head instead of the royal arms, and for its proper title was substituted, "The folly of England and the ruin of America." The House of Representatives in Virginia, under the guidance of Patrick Henry, drew up a spirited remonstrance to be laid before the king; other colonial legislatures, imitating the example of Virginia, did the same thing ere the several governors could dissolve them; and the people bound themselves not to buy any British thing with which they could possibly dispense until the obnoxious tax should be repealed.

In England the strongest efforts were made to procure a repeal of the Act. All the eloquence of Mr Pitt, all the learning of Lord Camden, all the oratory of Mr. Burke, all the authority of the largest-hearted and clearest-sighted statesmen of the day were employed to convince the king and his ministers of the danger in which the country stood in respect of the colonies, and to devise some means by which that danger might be averted. Pitt declared it as his opinion that the Stamp Act ought to be repealed "absolutely, totally, and immediately. That the reason for the repeal be assigned, because it was founded on an erroneous principle;" and upon this advice the Government was forced to act. The Stamp Act was repealed,

though accompanied by an Act declaring the right of the Crown to legislate for the colonies as the Home Government thought fit.

After the experience thus gained, though at the cost of allowing the Americans to discover how strong they were, it might have been thought the Government would have been wiser than to irritate the sensitive feelings of the people by again touching them on the tender point of money. But in 1767 it was determined to attempt to raise revenue out of new customs duties on articles, supposed to be necessaries, which were imported into the colonies. Boston was again the head-quarters of the excise, and the people, indignant at the disposition to coerce them, especially after their clearly expressed feeling on the subject of imposts, showed an intention to resist violently if need were. The severity with which the smuggling trade was suppressed, and the annoyances to which several of the assemblies were exposed from injudicious governors, added to the popular discontent, which rose to its height when it was found that a squadron of ships of war and four regiments of soldiers were to be sent to Boston to keep the people in check. Before the troops arrived, the people rose, sacked the houses of some of the excise officers, and compelled the Commissioners to seek safety in Castle William, at the mouth of Boston Harbour. This was in the autumn of 1768.

With the arrival of the troops a different state of things prevailed so long as force could overawe the people and keep them down; but there were frequent collisions between the townsmen and the soldiers, and after a while the troops were withdrawn from the immediate neighbourhood of Boston. Five years passed away, the Americans constantly raising objections to what was done by the Home Government, even in matters which were unquestionably within its proper authority; and the Home Government, and incidentally the Parliament and nation, grew tired of having such subjects. There was, in fact, in the American colonies too much of the republican spirit and notion of freedom which the earlier settlers in New England had brought thither, to allow of any abiding peace with the monarchy; and those who were loyal to the throne were made disgusted by the instrumentality of those who were not loyal, and were appealed to on the ground of the common injustice done to the colonies by the ill-advised acts of the Government in 1766. At length, in 1774, the smouldering flame burst forth.

The East India Company, who then had the monopoly of the trade in tea, had arranged with the English Government that they should have the drawback on all tea conveyed to America, and that the amount should be recovered through duties levied at the American custom-houses. As soon as the colonists heard of the arrangement they determined to frustrate it, for they fancied they saw in the tea-tax, as they called it, a forerunner of other domestic taxes, as hearth-tax, window-tax, and others equally hateful. Besides, they now questioned the right of Government to impose custom duties on them for the general expenses of the empire, and they resolved to withstand the tea-tax accordingly.

Before the ships arrived in Boston Harbour the people gave notice to the consignees that they should not gain by their cargoes; some of the agents they induced to renounce their agencies, and to promise that as soon as the vessels came they should be sent back again without being discharged; the pilots were warned not to bring any of the obnoxious ships into port; and steps were taken for still further pursuing the matter should these measures prove ineffectual. When the tea-ships came, the action begun at Boston was followed at all the other ports—the cargoes when landed were stored purposely in cellars; and the people having bound themselves not to use tea, and so to avoid a sale of the consignments, the article rotted, and was lost. In other cases the cargoes were sent back as they came, while at Boston the people were not content with such negative measures, but disguised at Mohawk Indians, they rushed by night on board three ships in the harbour, rummaged the cargo, and threw some £18,000 worth of tea into the sea. This last performance took place in December, 1773, and the actors in it having escaped without punishment, the British Government at home was determined to take the matter up sharply.

A bill was brought in and passed, whereby the port of Boston was declared to be closed, during the king's pleasure, against all commercial operations, though Pitt, Burke, and some of the leading men in both Houses raised their voices in loud protest against a punishment so far in excess of the offence, especially without first asking the city of Boston to make good the loss incurred by the tea-shippers. Acting according to his lights—but how great was the darkness of those lights!—Lord North and his colleagues carried their coercive measure against Boston, and another, yet more stinging and stringent, against the county of Massachusetts itself, by which the whole power in the county was taken away from the people and centred in the governor and a council of his own choosing; the former governor was changed for a military man of decided ways and habits, and troops were promised to support him in case of need.

The colonies, too, were not behindhand in energetic measures. Virginia first proposed to sympathise practically with Boston, then the other colonies joined, and finally it was agreed that delegates should be chosen from each of the twelve colonies, who should meet in general congress at Philadephia for the purpose of deciding what combined action should be taken. On the 5th of September, 1774, fifty-five delegates, including George Washington and Patrick Henry from Virginia, met in congress at Philadelphia, and proceeded to deliberate with closed doors. What passed in the meeting is not of material importance, but the upshot was truly momentous. A declaration of rights, in which they claimed all the privileges of Englishmen—privileges they had neither surrendered, lost, nor forfeited by emigration —was drawn up, together with some other statements to the effect that several of the recent Acts of Parliament were contrary to the spirit and letter of English law, and that until they were repealed there would not be any harmony between Great Britain and her colonies. To give these declarations force, they further resolved, on the part of their constituents and themselves, not to import any of the products of England, her colonies, or dependencies, nor to export to them any American produce, until the obnoxious Acts had been repealed. Addresses were written to the king, and to the people of Great Britain, in which the case of the colonists was manfully set forth, and an appeal made to justice and fair play.

How these addresses were received, what action the Government took upon the conduct of the Americans, are matters to be remembered with shame, and will stand as a lasting warning to all shortsighted politicians who govern or misgovern our great Empire. Instead of examining into the case with impartiality, and doing then according to right, the Government took offence at its slighted dignity, and resolved to treat the Americans with sole reference to that; and so lost to us one of our greatest possessions.

The result was the United States. Continuous jarrings, and occasionally something more, went on between the Government and the colonists, till the latter did not scruple to declare their intention to throw off their allegiance. An extensive organisation, going right through the colonies, was prepared with secresy, collections of arms and stores were made, the militia were drilled, everything was got ready for the emergency which all knew must arise sooner or later. Hostilities commenced in April, 1775, and from this moment civil war began in earnest, and was continued with varying success for six years, by which time the American soldiers, under George Washington, and the American people, under the guidance of Henry, Jefferson, Adams, Franklin, and Lee, made good, as against all the world, the declaration of independence which they made on July 4, 1776. "The Declaration," says Bancroft, "was not only the announcement of the birth of a people, but the establishment of a national government. The war was no longer a civil war; Britain was become to the United States a foreign country. Every former subject of the British king in the thirteen colonies now owed primary allegiance to the dynasty of the people, and became a citizen of the new Republic." The British troops fought bravely enough, but were badly handled; the American troops fought equally well and were admirably handled, and had the satisfaction to receive, as the reward of their valour, the surrender of almost all the British forces with their generals in succession. Finally, the British king was obliged tardily and reluctantly to acknowledge (Dec. 5th, 1782) the independence of his former colonies, to treat with them on the basis of an independent nation, and to accept a representative from them for all international purposes, but it was not till November, 1783, that the British troops evacuated New York. The war cost the colonials some £50,000,000, but independence was not dear even at such a price, and the English lost half a continent, and added £115,000,000 to their debt.

The Americans now had to determine the form of their Federal Republic, a work that occupied them for the next three or four years; and Washington, when raised to the position of the first President, added to his renown as a soldier the fame of a great and patriotic ruler.

More than a century has elapsed since Independence Day first dawned. In the course of that time each side has found out that there is room enough for both in the world, and that there is no reason why they should not exist with peace and goodwill towards each other. Old jealousies, old suspicions, old animosities have died away; new principles, new bonds of union have taken their place; so that as an American of to-day still takes pleasure in England as the old home of his race and his family, so an Englishman of to-day finds no difficulty in sympathising with him when he talks about American independence, and relates with justifiable pride and satisfaction the story of how in the old time the States came to earn their motto—*E pluribus unum!*

See:—Bancroft, *History of the United States; Cassell's Illustrated History of the United States.*

MUSIC.—XIX.

ontinued from Vol. III., p. 336.]

TRIPLETED MEASURES.

(TONIC SOL-FA.)

IT is often found convenient to represent tripleted time by a form of notation different from that described above. So long as rhythmic *relations* are clearly expressed, it is not of much consequence how they are written. The essential effects heard when a triplet is performed are (1) that the three notes are of equal value, and (2) that the first is the most strongly accented. These facts can be as well shown by writing three notes in three separate pulses with the direction to perform quickly, or in one beat for the three, as by writing in one pulse with inverted commas. When there are many half-thirds or sixths in a movement this spread out form of notation is peculiarly convenient. The two examples that follow show two ways of writing precisely the same effects.

(*a*) |m ,f ,s :l ,- ,f |r ,m ,f :s ||
(Two-pulse measure.)

(Three pulses to a beat.)
(*b*) |m :f :s |l :— :f |r : m : f |s :— :— ||
(Six-pulse measure.)

The pupil must learn to quickly see groups of three printed pulses, and to regard them as another way of expressing the effect of a pulse. The adoption of this form of notation for tripleted rhythm leads to the use of

Six-pulse for two-pulse measure.

| : : | : : ||
| : ||

Nine-pulse for three-pulse measure.

| : : | : : | : : ||
| : : ||

Twelve-pulse for four-pulse measure.

| : : | : : | : : | : : ||
| : | : ||

There are cases, however, of the use of real six-pulse, nine-pulse, and twelve-pulse measure. These are known by the absence of any qualifying direction just after the Metronome rate, which implies that each beat is to stand for a printed pulse. When the beats are to be grouped into threes the words "twice," "three," or "four times," are added to the Metronome figure, according to the measure employed. The time names must be applied according to the *effect*. See the names added to the exercises below.

Ex. 164.

Doh is D. M. 60, twice (*i.e.*, the rate of beating is to be 60 to the minute, and each beat is to cover half the six-pulse measure).

|s :— :— |m :d :m |s :— :l |s :— :— }
TAA taa tai tee TAA tee TAA

|l :t :d^1 |s :m :d |r :— :m |f :— :m }
taa tai tee taa tai tee TAA tee TAA tee

|r :— :— |s :— :— |d :— :— |— :— : ||
TAA TAA TAA -AA

Ex. 165.

Doh is D.

|s :— :m |f :— :r |s :— :m |d :— :— }
TAA tee TAA tee TAA tee TAA

|r :— :m |f :— :r |s :— :m |d :— :— ||
TAA tee TAA tee TAA tee TAA

The following is a well-known example of tripleted rhythm, the varied uses of which are familiar to almost everyone.

Ex. 166.

Doh is E♭. M. 70, twice. *Old Song.*

:s_1 |*m :— :m |m :r :m |f :— :— |m :— }

:m |r :— :r |r :d :r |m :— :— |d :— }

:r |m :— :m |m :r :m |f :— :s |l :— }

(*End.*)

:d^1 |s :— :f |m :— :r |d :— :— || :m :f }

|s :— :s |l :— :l |s :— :— |— :m :f }

(*Repeat from * to End.*)

|s :— :s |l :— :l |s :— :— |— :— :f ||

The advantage of the expanded form of notation is most obvious when the effects derived from mixing sixths and thirds have to be noted. When written in the closer form, sixths are shown as follows:

Sixths of a pulse.

|sl,sf,mf :s ,fm,f ||

but when written in the wider form, the relations in value and accent are better shown as follows:

|s .l :s .f :m .f |s :f .m :f ||

The most used ways of dividing a beat into thirds and sixths are exhibited at the side of the following exercise.

6THS AND 3RDS.

```
|l    :l .l :l   ||
 taa   tefe  tee

|l    :- .l :l   ||
 TAA     fe  tee

|l    :—   :l .l ||
 TAA          tifi
```

Ex. 167.

Doh is C.

```
|d' :t.d' :t  | l  :s.l :s  }
|f  :m    :f  | s  :s.l :s  }
|l  :t.d' :r' | s  :l.t :d' }
|t  :d'   :r' | d' :—   :—  }
```

The following is a good example of the use of TAA fe tee:

Ex. 168.—THE TIGHT LITTLE ISLAND.

Doh is E♭. *Lively, and with spirit.*

M. 64, twice in a measure. *Old Song.*

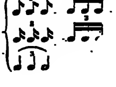
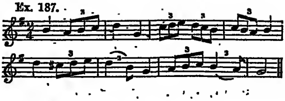
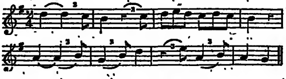
```
{:s.f |m  :-.f:m |m :f :s |l :-.t:l |l :t  :d' }
1. Daddy Nep-tune one day   to   Freedom did say, 'If
{|s :-.l:s  |s :f  :m |l :— :— |r :—  :s.f }
  ev - er I  lived up-on dry       land,  The
{|m :-.f:m  |m :f  :s |l :-.t:l |l :t  :d' }
  spot I should hit on would be little Bri-tain.' Says
{|s :-.l:s  |s :m  :d |r :— :— |d :—  :d }
  Free-dom, 'Why that's my own is - - land.' Oh!
{|d :— :d'  |t :l  :s |l :-.t:l |s :—  :d }
  what  a snug lit - tle is - - land! A
{|d :d' :d' |t :l  :s |l :— :— |s :—  :f }
  right lit- tle, tight lit - tle is - - land! Seek
{|m :-.f:m  |m :f  :s |l :-.t:l |l :t  :d' }
  all  the globe round there's none to be found  So
{|s :-.l:s  |s :f  :m |r :— :— |d :— ||
  hap - py as this lit - tle is - - land.'
```

(STAFF NOTATION.)

As the plan of the time signs of the Staff notation provides for only duple relations, special means have to be adopted to show ternary relations. These were briefly explained on p. 106, Vol. II. The commonest uses of triplets and ternary divisions generally are illustrated in the following examples. The notes used to show thirds vary of course with the pulse unit. Thus, in

$\frac{2}{4}$ $\frac{3}{4}$ $\frac{4}{4}$

$\frac{2}{8}$ $\frac{3}{8}$ $\frac{4}{8}$ thirds are shown as follows:—

$\frac{2}{2}$ $\frac{3}{2}$ $\frac{4}{2}$

Ex. 187.

Ex. 188.

COMPOUND TIME.

When a movement abounds in tripleted effects it is almost invariably written *with a dotted crotchet for a pulse*. Thirds are then easily shown without the complications arising from the use of figures over notes—a quaver standing for a third and a crotchet standing for two-thirds (of a dotted crotchet). It is one of the anomalies of the Staff notation that when the dotted crotchet is used as a pulse the time signature counts the number of *quavers* in the bar or measure. Thus when there are two "counts" or pulses in a bar, each shown by a dotted crotchet, the time signature is $\frac{6}{8}$, implying a six-pulse bar with a quaver for a pulse. From time to time efforts have been made to abolish the quaver signatures, and to substitute the signatures 2 over ♩. or 3 over ♩. or 4 over ♩. as called for. Just as with crotchet time, there are bars of two pulses, three pulses, and four pulses in dotted-crotchet time. The signatures of these measures are said to show COMPOUND TIME. In Germany, however, all bars beyond "two" and "three" times are classed as compound times.

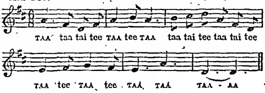
Table of Compound Time Signatures.

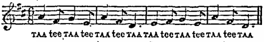
Signatures.	Effect.	Specimen bar.
$\frac{6}{4}$ (1) $\frac{6}{8}$ (1)	Two-pulse or Duple.	𝅗𝅥 . 𝅗𝅥 ♩ ♩. ♪ ♪ ♪
$\frac{9}{4}$ (rare) $\frac{9}{8}$ $\frac{9}{16}$ (rare)	Three-pulse or Triple.	𝅗𝅥. 𝅗𝅥. 𝅗𝅥. ♩. ♩. ♩. ♪. ♪. ♪.
$\frac{12}{8}$ $\frac{12}{16}$ (rare)	Four-pulse or Quadruple.	♩. ♩. ♩. ♩. ♪. ♪. ♪. ♪.

(1) Sometimes these signatures cover slow moving times. In such cases six must be counted, and the effect is of two three-pulse measures with a slight modification of accent.

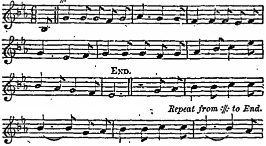
♩. = M. 60. (i.e., the rate of beating is to be 60 to the minute and each beat is to cover a dotted crotchet.)

Ex. 189.



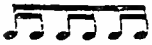
Ex. 190.

Ex. 191.

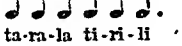
♩. = M. 70. Old Song.



SIXTHS OF A PULSE.

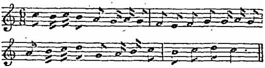
Sixths are shown in crotchet time by a group of six semiquavers with the figure 6 above. If the accent is to group the sixths into three twos the semiquavers are—or at least should be—arranged as follows:—

 sixths of a ♩ with *three* accents; and,
ta-fa te-fe ti-fi

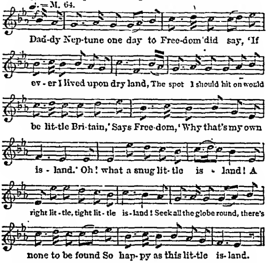
if into two threes, as follows:— 
ta-ra-la ti-ri-li

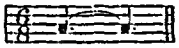
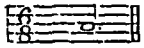
6ths and 3rds in ♩. time.	
taa te-fe tee	
TAA	fe tee
TAA	ti-fi

In compound time with dotted crotchets for pulses only sixths with three accents are used, and these are naturally shown by semiquavers. The exercises that follow illustrate some of the commonest rhythms that employ semiquavers in dotted-crotchet time.

Ex. 192.

Ex. 193.—THE TIGHT LITTLE ISLAND.

Old Song.

Lively, and with spirit. Six eight time.

Quick six-eight time being practically two dotted-crotchet time, notes more than one pulse in value are preferably shown by ties rather than by shapes that express value but not rhythm. A note lasting a whole measure of six-eight time is better written thus—

 than thus— 

because in the latter case the beginning of the second beat is not shown to the eye.

CHANGES OF KEY—TRANSITION.

Hitherto the position of the *doh* or key-note has not been altered in the course of any one exercise, although successive exercises have started in keys of different pitches. As changes of key frequently occur, even in the simplest music, it is necessary for the student to gain the power of making changes of key with his voice, and to fully understand the difficulties involved in their expression by notation. The movement from key to key is called TRANSITION (Latin *transitus*, passed over). There are as many transitions possible as there are key-pitches (*see* table of keys, p. 260, Vol. II.) to go to or from, and in modern times composers make use of any or all of these changes just as their fancy impels them. But some particular transitions are of much more frequent occurrence than others,

because they have a smooth, pleasant effect, and withal are infinitely easier to sing than those more rarely used. It is with these easy changes that in these lessons we shall have most to do. The easiest changes are those that turn **d r m f** into **s_1 l_1 t_1 d**, or **s l t d^1** into **d r m f**. In the first case it is easy to see that the *fah* of the new key will fall in the place of *ta* of the old key, and in the second case that *te* of the new key will fall in the place of *fe* of the old key. So in each case the new key calls for only *one* tone different in pitch from any diatonic tone of the key quitted. Transitions of this order are called ONE or FIRST REMOVE transitions.

ONE REMOVE.

s	d^1	f
	t	m
f		
m	l	r
r	s	d
		t_1
d	f	
t_1	m	l_1
l_1	r	s_1
s_1	d	f_1

The reason why transitions of any kind are difficult to the unaccompanied singer is owing to the fact that when the related tones of a key of any pitch are once firmly established in the ear the memory gives them up reluctantly. The difficulty is most felt therefore when transitions necessitate the rejection of many tones of the key left; for instance, when the old *te* is regarded as the new *doh^1*. But in one-remove transitions practice has to be directed mainly to the realisation of the new mental effects of the old sounds. See the diagram that follows:—

FIVE REMOVES.

C		doh^1	
B		te	d^1
	A♯		t
A		lah	
	G♯		l
G		soh	
	F♯		s
F		fah	
E		me	f
	D♯		m
D		ray	
	C♯		r
C		doh	
B_1		te_1	d

CHANGES OF MENTAL EFFECT IN ONE-REMOVE TRANSITION.

s	bold	doh^1	conclusive	f	serious and expectant
f	serious and expectant	te	bright and expectant	m	tranquil
m	tranquil	lah	sad	r	expectant
r	expectant	soh	bold	d	conclusive
				t_1	expectant
d	conclusive	fah	serious and expectant		
t_1	expectant	me	tranquil rest	l_1	sad
l_1	sad	ray	expectant	s_1	firm
s_1	firm	doh	conclusive	f_1	grave

It may be asked what is gained by going from a set of scale effects to another set exactly the same, but higher or lower in pitch? The answer to this question forcibly illustrates the demands made by music, and especially modern music, upon the memory and the unconscious power of comparison possessed by the listener. It has been pointed out that when once the tones of any key are firmly established in the ear they are not easily banished. A change of key persuades the ear to regard the old sounds in a different aspect, and calls attention to one or more new sounds. But the ear is coy, and for a while, at least, the old effects linger in the memory and get blended with the new effects, and so form a nuance found by composers to be one of the most fascinating resources of musical effect.

DISTINGUISHING TONES—SHARP AND FLAT REMOVES.

The tones that are new in a transition, *i.e.*, that differ in pitch from one or more tones of the key quitted, are called DISTINGUISHING TONES. If the distinguishing tones are sharper than the tones of the old key ignored, the transition is called a SHARP REMOVE, and if flatter, a FLAT REMOVE. *Soh* becoming *doh* (key C to key G, say) is a sharp remove, and *fah* becoming *doh* (key C to key F, say) is a flat remove. Removes are numbered according to the number of distinguishing tones required.

PERFECT AND IMPERFECT METHODS OF SHOWING TRANSITION.

It is clear that by using *fe* or *ta*, passages really in the first sharp or the first flat key can be *named* in the key already established. In this case the names will be sung in association with unaccustomed effects, a *fah* sounding like a *doh*, and so on. But impracticable as this appears to be, it is often the best plan when changes of key are of short duration; the fact being that quite enough of the old effects clings to the tones to maintain the connection. Music thus sol-faed is said to be written on the IMPERFECT METHOD, and when the syllables are more strictly applied the music is said to be written on the PERFECT METHOD.

COMMON MUSICAL TERMS.

[*Continued from p. 340, Vol. I.*]

	Pronunciation.	*Meaning.*
Largo	Lah'-go	Solemn and slow.
Adagio	A-daa'-zhe-o	Slow and expressive.
Lento	Len'-to	Slow.
Andante	An-dan'-tai	"Going" easily and rather slowly.
Allegretto	Al-la-gret'-to	Cheerful.
Allegro	Al-la'-gro	Quick, lively.
Presto	Pres'-to	Very quick.
Vivace	Ve-vaa'-chai	Quick and very lively.
Molto	Mol'-to	Extremely, or very.
Sempre	Sem'-prai	Always, or throughout
Dolce	Dol'-chai	Sweetly.

GEOLOGY.—X.

[*Continued from Vol. III., p.* 368.]

HISTORICAL GEOLOGY (*continued*)—THE ARCHÆAN AND PALÆOZOIC GROUPS.

PROFESSOR HULL has estimated the total maximum thickness of the stratified rocks at about 177,000 feet or 33 miles, assigning 32,750 feet or over 6 miles to the Laurentian or Archæan, 28,000 feet to the Cambrian, 27,000 feet to the Ordovian, 4,000 to the Silurian, 25,000 to the Devonian, 21,000 to the Carboniferous, and 4,000 to the Permian, or over 20 miles to the Palæozoic group, and nearly 5 miles to the Secondary group.

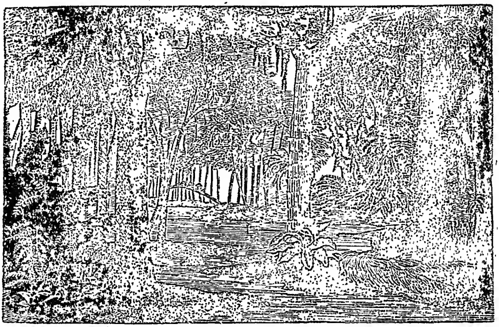


Fig. 17.—IDEAL LANDSCAPE OF THE COAL MEASURES.
The Trees at the sides are Lepidodendra, that in the middle is a Calamite.

ARCHÆAN GROUP.

These oldest known rocks (Greek ἀρχή, *archē*, beginning) are sometimes called Pre-Cambrian. They are mostly crystalline, consisting all over the world very largely of gneiss and mica, and other schists, with bands of quartzite, serpentine, crystalline limestones, graphite, hæmatite, and magnetite. These bands appear stratified, but are generally inconstant in thickness. The beds of limestone and iron-ore, and especially the graphite, have been believed to point to the existence of organic action when these rocks were formed, and to their extreme regional metamorphism since that formation. No undoubted fossils have been found in them; but in Canada in rocks of this age serpentine and limestone occur intimately associated, and presenting a remarkable tubular structure closely resembling organic forms, and described by Sir J. W. Dawson as *Eozoön canadense* ("the Canadian dawn-animal"), a reef-building foraminifer. Other authorities dispute its organic nature; and, as graphite occurs in meteoric stones, it is quite conceivable that under a very high temperature and pressure it might be chemically formed from hydro-carbons. Limestone and iron-oxide may easily have been formed by purely inorganic action; and the petrographical uniformity of these Archæan rocks in many parts of the world is urged as an argument in favour of their origin as precipitates from the primitive nebulous atmosphere. Rocks referred to this group form the axis of Charnwood Forest, Leicestershire, the Wrekin and the Malvern Hills. They occur in North Wales, Anglesea, and in the neighbourhood of St. David's, where Dr. Hicks has estimated their thickness at 18,000 feet, and divided them into three groups, named from local tribes, etc., *Dimetian*, *Arvonian*, and *Pebidian**. In the Hebrides and the Highlands of Scotland, gneiss, often granitic, and schists known as *Lewisian*, *Hebridean*, or *Fundamental*

* In enumerating subdivisions in the text (not in tables), the lowest or oldest will always be first mentioned.

because they have a smooth, pleasant effect, and withal are infinitely easier to sing than those more rarely used. It is with these easy changes that in these lessons we shall have most to do. The easiest changes are those that turn **d r m f** into **s_1 l_1 t_1 d**, or **s l t d^1** into **d r m f**. In the first case it is easy to see that the *fah* of the new key will fall in the place of *ta* of the old key, and in the second case that *te* of the new key will fall in the place of *fe* of the old key. So in each case the new key calls for only *one* tone different in pitch from any diatonic tone of the key quitted. Transitions of this order are called ONE or FIRST REMOVE transitions.

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	t	m
f		
m	l	r
r	s	d
		t_1
d	f	
t_1	m	l_1
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s_1	d	f_1

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B	te	d^1
A♯		t
A	lah	
G♯		l
G	soh	
F♯		s
F	fah	
E	me	f
D♯		m
D	ray	
C♯		r
C	doh	
B_1	te_1	d

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r	expectant	soh	bold	d	conclusive
d	conclusive	fah	serious and expectant	t_1	expectant
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l_1	sad	ray	expectant	s_1	firm
s_1	firm	doh	conclusive	f_1	grave

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Presto	Pres'-to	Very quick.
Vivace	Ve-vaa'-chai	Quick and very lively.
Molto	Mol'-to	Extremely, or very.
Sempre	Sem'-prai	Always, or throughout.
Dolce	Dol'-chai	Sweetly.

phyllopod. These beds are well developed near Barmouth, where gold occurs in them. Shales of similar age in the Malvern hills contain *Dictyograptus*, the earliest graptolite. The *Tremadoc slates*, besides trilobites, have yielded the earliest star-fish, crinoid, *Pelecypoda*, and cephalopod, *Orthoceras sericeum*. Cambrian rocks occur in Wicklow and Wexford, Scandinavia, Brittany, the Ardennes, and Bohemia, and are represented by the Acadian and Potsdam series in North America.

THE ORDOVIAN SYSTEM.

This system, sometimes called *Ordovician*, is named from the Ordovices, an ancient tribe of Central Wales. It is the Upper Cambrian of Sedgwick, the Lower Silurian of Murchison. As there is no marked unconformity among Cambrian rocks, so no stratigraphical break separates them from the Ordovian. The Ordovian system consists of greywackes, sandstones, grits, flagstones, shales, or slates, with limestones in the upper part, and important contemporaneous lavas, including felsites, diabases and diorites, and tuffs throughout the system. The most characteristic group of fossils in the system is that of the graptolites; but trilobites, such as *Asaphus*, *Ogygia*, and *Trinucleus*, and brachiopods, such as *Orthis*, were abundant, and the gastropods *Murchisonia* and *Euomphalus*, and numerous cystideans occur. With the occurrence of limestone, corals first become abundant. The series into which the Ordovian is divided are as follows:—

Lower Llandovery series. 1,000 feet. Grits and sandstones.
Bala and Caradoc series. 6,000—12,000 feet. Sandstones, slates, and grits, with Bala and Coniston limestones.
Llandeilo flags. 2,500 feet.
Arenig or Stiper Stone series. 4,000 feet. Dark slates and sandstones, with Skiddaw slates. 12,000 feet.

The *Arenig series* is named from the Arenig mountains in Merionethshire. They are conformable to the underlying Tremadoc rocks. The quartzose Stiper Stones between Shrewsbury and Bishop's Castle, and the dark slates and chiastolite slates of Skiddaw and the Isle of Man belong to this series. Thousands of feet of felsite, liparite, and tuff are interstratified with it, as in Cader Idris, and ores of lead and copper occur in Skiddaw. Graptolites, such as *Didymograptus*, are the most abundant fossils; but among trilobites *Calymene*, *Homalonotus*, *Phacops*, and *Trinucleus* appear for the first time, and the pteropods *Conularia* and *Theca*, *Orthis calligramma* and other brachiopods, the cephalopod *Orthoceras* and others, occur. The *Llandeilo series*, named from Llandeilo in Carmarthenshire, occur also near St. David's, and are represented by the great volcanic mass of the Borrowdale series, or "green slates and porphyries," 7,000 to 10,000 feet thick, in the Lake District, and by the black graptolite shales of Moffat and the south of Scotland. In addition to graptolites, pteropods, *Bellerophon*, *Murchisonia*, and *Orthoceras*, the brachiopods *Rhynchonella* and *Strophomena* occur for the first time, and the trilobites *Ogygia buchii* and *Asaphus tyrannus* are characteristic. The *Bala series* of dark slates and sandstones, with a lower or Bala, and an upper or Hirnant, limestone, twenty-five and ten feet thick respectively, and thousands of feet of contemporaneous felsites and tuffs, make up Snowdon, and are represented by yellowish sandstones round Caer Caradoc in Shropshire, and by the Coniston limestone in the south of the Lake District. Besides graptolites, such as *Monograptus*, numerous trilobites, especially *Phacops* and *Illænus*, *Orthis* and other genera of Mollusca, mentioned as in Llandeilo beds, crinoids, polyzoa, and forty species of coral, including *Halysites*, the chain-coral, and *Favosites*, honey-comb coral, occur in the limestones. The *Lower Llandovery series*, locally unconformable with Bala beds, extends south-east of Bala Lake, covering a great part of South Wales and the shores of Cardigan Bay. Though often separated from them by an unconformity, they form petrographically and palæontologically, a gradual transition to Silurian rocks. One of their most characteristic fossils is the brachiopod *Pentamerus* (*Stricklandinia*) *lens*.

THE SILURIAN SYSTEM.

The volcanic action prevalent during Ordovian times would seem to have resulted during the Llandovery period, in Wales at least, in extensive upheaval and its resultant denudation. What had been a wide though shallow sea was, as Sir Andrew Ramsay showed, elevated into a series of islands round whose shores the conglomerates and other rocks of the Silurian were laid down unconformably. Slow subsidence seems to have been in progress throughout the Silurian epoch, the rocks being sandstones and shales, with reefs of limestone, all indicative of shallow sea. The system, the Upper Silurian of Murchison, was named by him from the ancient British tribe, the Silures, in South Wales. Somewhat doubtful traces of land-plants have been found near the top of the system, with remains, both in Scotland and in Scandinavia, of scorpions, and an insect has been described from still lower beds in France. Graptolites still lingered, trilobites and brachiopods still abounded, in the limestones corals and crinoids are numerous, and, apparently towards the close of the epoch, the *Eurypterida* or broad-tailed king-crabs and the *Vertebrata*, as represented by a few ganoid fish,

made their first known appearance on the earth. The system is thus subdivided in Britain :—

Ludlow series. 1,950 feet. Shales, with Aymestry limestone.
  Ledbury shales. 200 feet.
  Downton sandstones. 100 feet.
  Upper Ludlow, with bone-bed and Kirkby Moor flags.
  Aymestry limestone. 20—40 feet.
  Lower Ludlow, with Bannisdale slates.
Wenlock series. 3,000—7,000 feet. Slates, shales, grits, and limestones.
  Wenlock or Dudley limestone. 100—300 feet. | Denbigh and Coniston grits. 3,000—7,000 feet.
  Wenlock shale. 640—1,100 feet. |
  Woolhope or Barr limestone. 40 feet. |
  Tarannon shale. 1,000—1,500 feet. Stockdale slates.
Upper Llandovery or May Hill series. 1,500 feet. Sandstones.

The *Upper Llandovery series*, known also as the May Hill series from its occurrence at May Hill in Gloucestershire, closely resembles the Lower Llandovery sandstones, but rests unconformably upon various older rocks, and is characterised by *Pentamerus oblongus*. Together with the Lower Llandovery it has been termed "the Pentamerus beds." The Lickey Hills in Worcestershire are chiefly composed of quartz rock of this age. *Atrypa reticularis*, *Strophomena*, and other brachiopods are abundant; corals, many trilobites, including *Calymene blumenbachii*, and the first known echinoid, *Palæchinus*, occur. The *Tarannon shale* in South Wales rests conformably on the May Hill series; but in North Wales is the lowest Silurian series present. It consists largely of pale blue and greenish slates. The *Stockdale slates* of the Lake District, containing graptolites, are also termed Graptolitic Mudstones. The *Woolhope* or *Barr limestone*, named from the periclinal valley of elevation of Woolhope, near Hereford, and from Barr in Staffordshire, and occurring also at Malvern, though thin, is rich in trilobites, including *Homalonotus delphinocephalus*, *Phacops caudatus*, and *Illænus barriensis*, and in brachiopods, including *Rhynchonella wilsoni*. The *Wenlock shale* extends through South Wales, thickening northward. *Orthis*, *Phacops*, and *Monograptus* are among its more frequent fossils. The *Wenlock limestone*, forming the ridge known as Wenlock Edge in Shropshire, and well seen also at Dudley, Woolhope, Malvern, and May Hill, is a light grey rock largely quarried for lime, and forming at Ledbury an oolitic marble. It is full of corals, crinoids, trilobites, brachiopods, etc., including most of the Woolhope species, with the corals *Favosites gothlandica* and *Omphyma turbinatum*, the cystidean *Pseudocrinites* and the earliest eurypterids, *Eurypterus* and *Pterygotus*. The thick beds known as *Denbigh grits* in North Wales, and as *Coniston grits and flags* in the Lake District, are comparatively poor in fossils, as are also the overlying *Bannisdale slates* and *Kirkby Moor flags*, of Ludlow age, in the latter area. The *Ludlow series*, named from Ludlow in Shropshire, are a great series of shales graduating downward into the Wenlock, with an occasional zone of limestone and a bone-bed, and becoming sandy, so as to pass, in South Wales, gradually upward into the Old Red Sandstone. The oldest known vertebrate, a fragment of a fish, *Scaphaspis ludensis*, has been found in the Lower Ludlow. *Pentamerus knightii* is characteristic of the Aymestry limestone. The bone-bed at the top of the Upper Ludlow is a layer, less than a foot thick, full of fragments of *Pterygotus* and of fish, including *Cephalaspis* and *Pteraspis*, and traceable over 1,000 square miles to the south of Ludlow. The *Downton sandstones*, named from Downton Castle, inappropriately called tilestones, solely from their red colour, by Murchison, and the *Ledbury shales* form, in this Ludlow and Ledbury area, an imperceptible gradation or series of "passage-beds" up into the Old Red Sandstone. In North Wales, on the other hand, Silurian rocks have been tilted, crumpled, faulted, and cleaved before being covered unconformably by that system. Silurian rocks have been reached by deep borings near London; they rise to the surface in many parts of the Continent from Spain to the Urals, especially in Bohemia; and occupy a large area in Canada and New York.

THE DEVONIAN AND OLD RED SANDSTONE SYSTEMS.

Both in Europe and in eastern North America Silurian rocks are succeeded by others which, even in closely neighbouring areas, represent two nearly contemporaneous, but altogether dissimilar, sets of geographical conditions. In north-west Europe, New Brunswick, and Nova Scotia, the floor of the Silurian sea seems to have been irregularly elevated so as to form great salt lakes, in which sand was deposited with red iron-oxide, rock-salt, gypsum, and magnesian limestone, with drifted land-plants and insect-remains, but under conditions generally unfavourable to aquatic animal life. Dr. Archibald Geikie has traced five of these lakes in Britain :— (i.) The Welsh Lake, the area of which, as we have just seen, presents a gradual passage upward from Silurian rocks, but with a dying-out of the Silurian types of marine life; (ii.) Lake Cheviot; (iii.) Lake Caledonia, extending from the north of Ireland through the central valley of Scotland; (iv.) Lake Lorne, mainly in Argyleshire; and (v.) Lake Orcadie, extending from Elgin, through Caithness and the Orkneys, to the Shetlands. This lacustrine type is known as the OLD RED SANDSTONE, from its chief rock, which occurs in synclinal folds below many of our coal-fields, and so is obviously older than the somewhat similar red sandstones, the

New Red, which often rest upon the Coal-measures. Over what is now Devon and Cornwall, Brittany, London, Belgium, the Rhine, and the Harz, and in the Alleghanies, a more truly marine or open-sea type of deposits, known as *Devonian*, prevailed, consisting of sandstones and greywackes, locally altered into slates, with thick beds of limestone. Thick layers of volcanic rocks, felsites, tuffs, and diabases occur associated with both types, forming, for instance, the Pentland, Ochil, and Sidlaw hills; and the Devonian rocks of Devon, Cornwall, and the Harz contain veins of lead, tin, copper, and iron ores, and those of Pennsylvania yield petroleum. The Old Red Sandstone, which, as we have seen, passes conformably downwards into the Silurian, is from 4,000 to 25,000 feet in thickness, and seems to be generally separated into a Lower and an Upper portion by an unconformity, the latter division passing conformably up into Carboniferous rocks. Like most red sandstones, it contains few fossils, save in a few localities. The *Lower Old Red Sandstone series*, including the Arbroath flags and valuable Caithness flags, and probably represented by the Glengariff grits, 10,000 feet thick, in south-west Ireland, yields a land flora including the club-moss *Lepidodendron*, the horse-tail *Calamites*, *Sigillaria*, etc., the eurypterid *Pterygotus anglicus*, sometimes six feet long, and various fish, such as *Pteraspis*, *Cephalaspis*, and *Asterolepis*. Gigantic allied fish, insects, myriapods, and traces of land-snails have been found in the American deposits. The *Upper Old Red Sandstone series* includes the Dura Den beds in Fifeshire, crowded with *Holoptychius* and other fish, and the Kiltorcan beds of Kilkenny, in which the fern *Palæopteris* and the fresh-water mussel *Anodon jukesii* occur. The Devonian fauna includes the last few graptolites; numerous corals, especially *Calceola sandalina* and *Cyathophyllum*; crinoids such as *Cyathocrinus*; trilobites in reduced variety, including especially *Bronteus*; no less than 1,100 species of brachiopods, the class reaching in these rocks its maximum development, and including *Orthis*, *Strophomena*, *Atrypa*, *Stringocephalus*, *Spirifer*, and *Productus*; among cephalopods, the ammonitids *Goniatites* and *Bactrites*, as well as the nautilid *Orthoceras*; and occasional fish-remains identical with those of the Old Red Sandstone. The system, 10,000 feet thick, is subdivided as follows:—

Upper.—Pilton and Pickwell Down series. Slates, etc.
Middle.—Ilfracombe and Plymouth limestones, etc. Calceola limestone of Germany. Stringocephalus limestone of the Eifel.
Lower.—Linton series. Soft slates and sandstones.

The system includes the *killas* or slate of Cornwall, which is the matrix of many mineral veins, and also valuable marbles; and the Old Red Sandstone forms the rich soil of Hereford orchards and hop-gardens, and of the Carse of Gowrie. Devonian rocks similar to those of Belgium are found in deep borings under London. The relations of the Devonian type with the Silurian below, and the Carboniferous above are not so clear as are those of the Old Red Sandstone.

THE CARBONIFEROUS SYSTEM.

The close of the Devonian epoch would seem to have been marked by great, though gradual, geographical changes, so that an open sea extended from the west of Ireland into Westphalia, undergoing during the earlier part of the Carboniferous epoch continuous depression, but shallowing towards land to the north of Derbyshire. Subsequently, during the latter part of the epoch, though depression must have continued, at least intermittently, the "lagoon type" of shallower water conditions seems to have extended southward over most of the area occupied previously by the "marine type." The epoch during which these changes were in progress is termed *Carboniferous* (Latin *carbo*, coal; *fero*, I bear) from the valuable beds of coal occurring mainly in the uppermost rocks belonging to it. In the open sea a very pure limestone, sometimes foraminiferal, sometimes crinoidal, and sometimes coralline, known as the Carboniferous, or, from the scenery it now often forms, as the Mountain Limestone, accumulated to a depth in some places exceeding 6,000 feet. The lagoon type, on the other hand, is represented by thousands of feet of sandstone and grit, with occasional conglomerate and shale, with seams of coal resting on beds of fire-clay, and with beds of clay-ironstone nodules. False-bedding, ripple-mark, and sun-cracks tell of the shallow-water origin of the sandstones, and the coal-seams mark successive forest-growths during considerable pauses in the sinking of the area (Fig. 17). Volcanic activity during the earlier part of the epoch is marked by intercalated rocks in Derbyshire, the Isle of Man, and especially in the south of Scotland, where some sheets reach a thickness of 1,500 feet. In Russia, China, and western North America, Carboniferous rocks cover large areas horizontally, as does the Carboniferous Limestone in Ireland; but in England the limestone forms the axial Pennine anticlinal from Northumberland to Derbyshire, and elsewhere the system is mainly preserved in synclinal "basins" or "coal-fields" (*see* Vol. I., p. 235) once united, but now detached. The limestones contain a rich marine fauna, 1,500 species having been described. They are largely composed of foraminifera, such as *Fusulina*; abound in corals, such as *Lithostrotion*

basaltiforme; in crinoids, such as *Platycrinus;* in polyzoans, especially *Fenestella;* in brachiopods, especially *Productus* and *Spirifer;* and in pelecypods; and contain the blastoid *Pentremites* in lieu of the Silurian cystideans, numerous gastropods, pteropods, and cephalopods; the last of the trilobites, *Phillipsia*, *Griffithides*, and *Brachymetopus;* and numerous fish, some of large size, represented by spines ("ichthyodorulites") and teeth like those of rays or sharks—*e.g.*, *Psammodus*, *Cochliodus*, etc. The flora of the shales and coal resembles that of the Devonian, including *Calamites*, *Lepidodendron*, and the problematic *Sigillaria*, all reaching the size of trees; ferns, such as *Alethopteris*, characterising the higher beds; and, apparently from higher ground, some little-known conifers. Mussels, probably fresh-water, such as *Anthracosia*, scorpions, millipedes, a great variety of insects belonging to a primitive type (*Palæodictyoptera*), combining in a generalised form the characters of several modern groups, especially from Commentry in France, land snails, such as *Pupa* and *Zonites*, and large salamander-like labyrinthodont amphibians, such as *Archegosaurus*, the earliest of their class, occur in the same beds with this flora, though an occasional band contains marine shells. The system may be subdivided as follows:—

Upper. Coal-measure series. (3,000 feet in Scotland; 12,000 feet in South Wales.)	Upper. 150—3,500 feet.
	Middle. With Pennant Grit. 3,000—4,000 feet.
	Lower. With Gannister (a siliceous fire-clay). 450—2,000 feet.
Middle. Millstone Grit. 300—5,500 feet.	
Lower. Carboniferous Limestone series.	Yoredale Shales and Grits. 300—4,500 feet.
	Thick or Scaur Limestone. 500—3,500 feet.
	Lower Limestone Shale or Tuedian, with Calciferous Sandstone of Scotland. 100—1,000 feet.

As will be seen, the divisions vary exceedingly in thickness. In the north a few coal-seams occur in the limestone and Millstone Grit, but in the south the latter is known as Farewell Rock, no coal occurring in or below it. From its barrenness it is called Moor Rock in the north. In South Wales there are about eighty coal-seams with a total thickness of 120 feet. It is probable that the highest beds of the Coal-measures, present in France, as at Autun, and in Bohemia, are absent in Britain. In addition to coal and iron, the system yields much valuable flagstone, especially the Yorkshire flags; the Craigleith or Calciferous sandstone for building: various marbles, millstones, grindstones, and honestones; ores of lead, copper, and zinc in veins in the limestone; and, by distillation of the often bituminous shales, paraffin, alum, and copperas.

ALGEBRA.—I.

DEFINITIONS.

1.—ALGEBRA is a general method of solving problems, and of investigating the relations of quantities by means of letters and signs.

The following will afford illustrations of this method of arriving at the solutions of problems by the use of signs and letters instead of figures as in arithmetic:—

PROBLEM I.—Suppose that a man divided 72 pounds among his three sons in the following manner:—To A he gave a certain number of pounds; to B he gave three times as many as to A; and to C he gave the remainder, which was half as many pounds as A and B received. How many pounds did the donor give to each?

To solve this problem *arithmetically*, the pupil would reason thus:—A had a *certain part*, that is *one share;* B received *three* times as much, or *three shares;* but C had *half* as much as A and B; hence he must have received *two shares*. By adding their respective shares, the sum is *six shares*, which, by the conditions of the question, is equal to 72 pounds. If, then, 6 shares are equal to 72 pounds, 1 share is equal to $\frac{1}{6}$ of 72, namely, 12 pounds, which is A's share. B had *three* times as many, namely, 36 pounds; and C *half* as many pounds as both, namely, 24 pounds.

Now, to solve the same problem by *algebra*, he would use *letters* and *signs*, thus:—

Let x represent A's share; then, by the conditions,

x multiplied by 3, or $x \times 3$ (when $\times$, the sign of multiplication, is used instead of the words "multiplied by"), will represent B's share, and

$4x$, the sum of the shares of A and B divided by 2, or $4x \div 2$ (when $\div$, the sign of division, is used instead of the words "divided by"), will represent C's share.

Now, $x \times 3$ may be written $3x$, and $4x \div 2$ may be written $2x$; so then adding together the several shares of A, B, and C, namely, x, $3x$, and $2x$, and putting $+$, the sign of addition, between them, we get $x + 3x + 2x$, which is equal to $6x$; or using $=$, the sign of equality, for the words "is equal to," we get $x + 3x + 2x = 6x$. Then $6x = 72$, for the whole is equal to all its parts; and $1x = 12$ pounds, A's share; $3x = 36$ pounds, B's share; and $2x = 24$ pounds, C's share.

Proof.—Add together the number of pounds received by each, and the sum will be equal to 72 pounds, the amount divided between A, B, and C.

In this *algebraic solution* it will be observed: *First*, that we *represent* the *number of pounds* which A received by x. *Second*, to obtain B's share, we

must *multiply* A's share by 3. This *multiplication* is represented by *two lines crossing each other like a capital X*. *Third*, to find C's share, we must take *half* the sum of A's and B's share. This *division* is denoted by *a line between two dots*. *Fourth*, the *addition* of their respective shares is denoted by *another cross formed by a horizontal* and a *perpendicular line*. Take another example:—

PROBLEM II.—A boy wishes to lay out 96 pence for peaches and oranges, and wants to get an equal number of each. He finds that he must give 2 pence for a peach, and 4 pence for an orange. How many can he buy of each?

Let x denote the number of each. Now, since the price of one peach is 2 pence, the price of x peaches will be $x \times 2$ pence, or $2x$ pence. For the same reason, $x \times 4$, or $4x$ pence, will denote the price of x oranges. Then will $2x + 4x$, or $6x$, be equal to 96 pence by the conditions of that question, and $1x$ or x (for when 1 is the co-efficient of a number [*see* Art. 16 below] it is always understood, and never expressed) is equal to $\frac{1}{6}$ of 96 pence, namely, 16 pence, and 16 is therefore the number he bought of each.

2. Quantities in algebra are generally expressed by *letters*, as in the preceding problems. Thus b may be put for 2 or 15, or any other number which we may wish to express. It must not be inferred, however, that the letter used has *no determinate* value. Its value is *fixed* for the *occasion* or *problem* on which it is employed, and remains *unaltered* throughout the solution of that problem. But on a *different* occasion, or in *another* problem, the same letter may be put for any other number. Thus, in Problem I., x was put for A's share of the money. Its value was 12 pounds, and remained fixed through the operation. In Problem II., x was put for the number of each kind of fruit. Its value was 16, and it remained so throughout the whole of the calculation.

3. By the term *quantity*, we mean anything that can be *multiplied*, *divided*, or *measured*. Thus, *length*, *weight*, *time*, *number*, etc., are called quantities.

4. The *first* letters of the alphabet, a, b, c, etc., are generally used to express *known* quantities; and the *last* letters, z, y, x, etc., those which are *unknown*.

5. *Known* quantities are those whose values are given, or may be easily inferred from the conditions of the problem under consideration.

6. *Unknown* quantities are those whose values are not given, but required.

7. *Sometimes*, however, the given quantities, instead of being expressed by letters, are given in *figures*.

8. Besides letters and figures, it will also be seen that we use *certain signs* or *characters* in algebra to indicate the *relations* of the quantities, or the *operations* which are to be performed with them, instead of writing out these relations and operations in words. Among these are the signs of addition (+), subtraction (—), equality (=), etc.

9. *Addition* is represented by two lines (+), one horizontal, the other perpendicular, forming a cross, which is called *plus*. It signifies "more," or "added to." Thus $a + b$ signifies that b is to be added to a. It is read a plus b, or a added to b, or a and b.

10. *Subtraction* is represented by a short horizontal line (—) which is called *minus*. Thus, $a - b$ signifies that b is to be "subtracted" from a; and the expression (*see* Art. 22 below) is read a minus b, or a less b.

11. The sign + is prefixed to quantities which are considered as *positive* or *affirmative*; and the sign — to those which are supposed to be *negative*. For the nature of this distinction, see Articles 36 and 37.

12. The sign is generally omitted before the *first* or *leading* quantity, unless it is *negative*; then it must *always be written*. When *no sign* is prefixed to a quantity, + is *always* understood. Thus $a + b$ is the same as $+ a + b$.

13. Sometimes both + and — (the latter being put under the former, $\pm$) are prefixed to the *same* letter. The sign is then said to be *ambiguous*. Thus $a \pm b$ signifies that in certain cases, comprehended in a general solution, b is to be added to a, and in other cases subtracted from it.

Observation.—When *all* the signs are *plus*, or *all minus*, they are said to be *alike*: when *some* are plus and *others* minus, they are called *unlike*.

14. The *equality* of two quantities, or sets of quantities, is expressed by two parallel lines, =. Thus $a + b = d$ signifies that a and b together are equal to d. So $8 + 4 = 16 - 4 = 10 + 2 = 7 + 2 + 3$.

15. When the first of the two quantities compared is *greater* than the other, the character > is placed between them. Thus $a > b$ signifies that a is greater than b.

If the first is *less* than the other, the character < is used; as $a < b$, namely a is less than b. In both cases the quantity towards which the character opens is greater than the other.

16. A numeral figure is often prefixed to a letter. This is called a *co-efficient*. It shows how often the quantity expressed by the letter is to be taken. Thus $2b$ signifies twice b; and $9b$, 9 times b, or 9 multiplied into b.

The co-efficient may be either a whole number or a fraction. Thus $\frac{2}{3}b$ is two-thirds of b. When the

co-efficient is not expressed, 1 is always to be understood. Thus a is the same as $1a$, that is to say, a once.

17. The co-efficient may also be a *letter*, as well as a figure. In the quantity mb, m may be considered the co-efficient of b; because b is to be taken as many times as there are units in m. If m stands for 6, then mb is six times b. In $3abc$, 3 may be considered as the co-efficient of abc; $3a$ the co-efficient of bc; or $3ab$ the co-efficient of c.

18. A *simple* quantity is either a single letter or number, or several letters connected together *without* the signs $+$ or $-$. Thus a, ab, abd, and $8b$, are each of them simple quantities.

19. A *compound* quantity consists of a number of simple quantities connected by the sign $+$ or $-$. Thus $a + b$, $d - y$, $b - d + 3h$, are each compound quantities. The members of which each is composed are called *terms*.

20. A *simple* term is called a *monomial;* thus, a, b, $-c$ are *monomials*. If there are *two* terms in a compound quantity, it is called a *binomial;* thus, $a + b$ and $a - b$ are binomials. The latter term $(a - b)$ is also called a *residual* quantity, because it expresses the *difference* of two quantities, or the remainder after one is taken from the other. A compound quantity, consisting of *three* terms, is sometimes called a *trinomial;* one of *four* terms, a *quadrinomial*. A quantity consisting of several terms is, however, generally called a *polynomial*.

21. When the several members of a compound quantity are to be subjected to the *same operation*, they are connected by a line called a *vinculum* (——), or by a *parenthesis* (). Thus $a - \overline{b + c}$, or $a - (b + c)$, shows that the *sum* of b and c is to be subtracted from a. But $a - b + c$ signifies that b is to be subtracted from a, and c is to be added to the result.

22. A single letter, or a number of letters, representing any quantities with their relations, is called an algebraic *expression* or *formula*. Thus $a + b + 3d$ is an algebraic expression.

23. *Multiplication* is usually denoted by two oblique lines crossing each other, thus $\times$: hence, $a \times b$ is a multiplied into b; and 6×3 is 6 times 3, or 6 multiplied into 3. Sometimes a *point* is used to indicate multiplication: thus, $a \,.\, b$ is the same as $a \times b$. But the sign of multiplication is more commonly omitted between simple quantities, and the letters are connected together in the form of a word or syllable: thus, ab is the same as $a \,.\, b$ or $a \times b$; and $bcdc$ is the same as $b \times c \times d \times c$. When a compound quantity is to be multiplied, a *vinculum* or *parenthesis* is used, as in the case of subtraction. Thus the sum of a and b multiplied into the sum of c and d, is $\overline{a + b} \times \overline{c + d}$, or $(a + b) \times (c + d)$. And $(6 + 2) \times 5$ is 8×5, or 40. But $6 + (2 \times 5)$ is $6 + 10$, or 16. When the marks of parenthesis are used, the sign of multiplication is frequently omitted. Thus $(x + y)(x - y)$ is $(x + y) \times (x - y)$.

24. When two or more quantities are multiplied together, each of them is called a *factor*. In the product ab, a is a factor, and so is b. In the product $x \times (a + m)$, x is one of the factors, and $(a + m)$ the other. Hence every *co-efficient* may be considered as a factor (Art. 17). In the product $3y$, 3 is a factor as well as y.

25. A quantity is said to be *resolved into factors*, when any factors are taken which, being multiplied together, will produce the given quantity. Thus $3ab$ may be resolved into the two factors $3a$ and b; because $3a \times b$ is $3ab$. And $5amn$ may be resolved into the three factors $5a$, and m, and n. And 48 may be resolved into the two factors 2×24, or 3×16, or 4×12, or 6×8; or into the three factors $2 \times 3 \times 8$, or $4 \times 6 \times 2$, etc.

26. *Division* is expressed in two ways: (1) By a horizontal line between two dots $\div$, which shows that the quantity *preceding* it is to be divided by that which *follows*. Thus $a \div c$ is a divided by c.

(2) Division is more commonly expressed in the form of a *fraction*, putting the dividend in the place of the numerator, and the divisor in that of the denominator. Thus $\frac{a}{b}$ is a divided by b.

27. When four quantities are *proportional*, the proportion is expressed by points, in the same manner as in the Rule of Proportion in arithmetic. Thus $a : b :: c : d$ signifies that a has to b the same ratio which c has to d. And $ab : cd :: a + m : b + n$ means that ab is to cd as the sum of a and m to the sum of b and n.

28. Algebraic quantities are said to be *like* when they are expressed by the same *letters*, and are of the same *power;* and *unlike* when the letters are different, or when the same letter is raised to different powers. Thus ab, $3ab$, $-ab$, and $-6ab$, are like quantities, because the letters are the same in each, although the signs and co-efficients are different. But $3a$, $3y$, $3bx$, are unlike quantities, because the letters are unlike, although there is no difference in the signs and co-efficients. So x, xx, and xxx, are *unlike quantities*, because they are different powers of the same quantity. (They are usually written x, x^2, and x^3.) And universally if *any quantity is repeated as a factor* a number of times in one instance, and a *different* number of times in another, the products will be *unlike quantities;* thus, cc, $cccc$, and c, are unlike quantities. But if the same quantity is repeated as a factor the *same number* of times in *each instance*, the

must *multiply* A's share by 3. This *multiplication* is represented by *two lines crossing each other like a capital* X. *Third*, to find C's share, we must take *half* the sum of A's and B's share. This *division* is denoted by *a line between two dots*. *Fourth*, the *addition* of their respective shares is denoted by *another cross formed by a horizontal* and a *perpendicular line*. Take another example:—

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10. *Subtraction* is represented by a short horizontal line (−) which is called *minus*. Thus, $a - b$ signifies that b is to be "subtracted," from a; and the expression (*see* Art. 22 below) is read a minus b, or a less b.

11. The sign + is prefixed to quantities which are considered as *positive* or *affirmative*; and the sign − to those which are supposed to be *negative*. For the nature of this distinction, see Articles 36 and 37.

12. The sign is generally omitted before the *first* or *leading* quantity, unless it is *negative*; then it must *always be written*. When *no sign* is prefixed to a quantity, + is *always* understood. Thus $a + b$ is the same as $+ a + b$.

13. Sometimes both + and − (the latter being put under the former, ±) are prefixed to the *same* letter. The sign is then said to be *ambiguous*. Thus $a \pm b$ signifies that in certain cases, comprehended in a general solution, b is to be added to a, and in other cases subtracted from it.

Observation.—When *all* the signs are *plus*, or *all minus*, they are said to be *alike*; when *some* are plus and *others* minus, they are called *unlike*.

14. The *equality* of two quantities, or sets of quantities, is expressed by two parallel lines, =. Thus $a + b = d$ signifies that a and b together are equal to d. So $8 + 4 = 16 - 4 = 10 + 2 = 7 + 2 + 3$.

15. When the first of the two quantities compared is *greater* than the other, the character > is placed between them. Thus $a > b$ signifies that a is greater than b.

If the first is *less* than the other, the character < is used; as $a < b$, namely a is less than b. In both cases the quantity towards which the character opens is greater than the other.

16. A numeral figure is often prefixed to a letter. This is called a *co-efficient*. It shows how often the quantity expressed by the letter is to be taken. Thus $2b$ signifies twice b; and $9b$, 9 times b, or 9 multiplied into b.

The co-efficient may be either a whole number or a fraction. Thus $\frac{2}{3}b$ is two-thirds of b. When the

co-efficient is not expressed, 1 is always to be understood. Thus a is the same as $1a$, that is to say, a once.

17. The co-efficient may also be a *letter*, as well as a figure. In the quantity mb, m may be considered the co-efficient of b; because b is to be taken as many times as there are units in m. If m stands for 6, then mb is six times b. In $3abc$, 3 may be considered as the co-efficient of abc; $3a$ the co-efficient of bc; or $3ab$ the co-efficient of c.

18. A *simple* quantity is either a single letter or number, or several letters connected together *without* the signs $+$ or $-$. Thus a, ab, abd, and $8b$, are each of them simple quantities.

19. A *compound* quantity consists of a number of simple quantities connected by the sign $+$ or $-$. Thus $a+b$, $d-y$, $b-d+3h$, are each compound quantities. The members of which each is composed are called *terms*.

20. A *simple* term is called a *monomial*; thus, a, b, $-c$ are *monomials*. If there are *two* terms in a compound quantity, it is called a *binomial*; thus, $a+b$ and $a-b$ are binomials. The latter term $(a-b)$ is also called a *residual* quantity, because it expresses the *difference* of two quantities, or the remainder after one is taken from the other. A compound quantity, consisting of *three* terms, is sometimes called a *trinomial*; one of *four* terms, a *quadrinomial*. A quantity consisting of several terms is, however, generally called a *polynomial*.

21. When the several members of a compound quantity are to be subjected to the *same operation*, they are connected by a line called a *vinculum* (——), or by a *parenthesis* (). Thus $a-\overline{b+c}$, or $a-(b+c)$, shows that the *sum* of b and c is to be subtracted from a. But $a-b+c$ signifies that b is to be subtracted from a, and c is to be added to the result.

22. A single letter, or a number of letters, representing any quantities with their relations, is called an algebraic *expression* or *formula*. Thus $a+b+3d$ is an algebraic expression.

23. *Multiplication* is usually denoted by two oblique lines crossing each other, thus $\times$: hence, $a \times b$ is a multiplied into b; and 6×3 is 6 times 3, or 6 multiplied into 3. Sometimes a *point* is used to indicate multiplication: thus, $a.b$ is the same as $a \times b$. But the sign of multiplication is more commonly omitted between simple quantities, and the letters are connected together in the form of a word or syllable: thus, ab is the same as $a.b$ or $a \times b$; and $bcdc$ is the same as $b \times c \times d \times c$. When a compound quantity is to be multiplied, a *vinculum* or *parenthesis* is used, as in the case of subtraction. Thus the sum of a and b multiplied into the sum of c and d, is $\overline{a+b} \times \overline{c+d}$, or $(a+b) \times (c+d)$. And $(6+2) \times 5$ is 8×5, or 40. But $6+(2 \times 5)$ is $6+10$, or 16. When the marks of parenthesis are used, the sign of multiplication is frequently omitted. Thus $(x+y)(x-y)$ is $(x+y) \times (x-y)$.

24. When two or more quantities are multiplied together, each of them is called a *factor*. In the product ab, a is a factor, and so is b. In the product $x \times (a+m)$, x is one of the factors, and $(a+m)$ the other. Hence every *co-efficient* may be considered as a factor (Art. 17). In the product $3y$, 3 is a factor as well as y.

25. A quantity is said to be *resolved into factors* when any factors are taken which, being multiplied together, will produce the given quantity. Thus $3ab$ may be resolved into the two factors $3a$ and b, because $3a \times b$ is $3ab$. And $5amn$ may be resolved into the three factors $5a$, and m, and n. And 48 may be resolved into the two factors 2×24, or 3×16, or 4×12, or 6×8; or into the three factors $2 \times 3 \times 8$, or $4 \times 6 \times 2$, etc.

26. *Division* is expressed in two ways: (1) By a horizontal line between two dots $\div$, which shows that the quantity *preceding* it is to be divided by that which *follows*. Thus $a \div c$ is a divided by c.

(2) Division is more commonly expressed in the form of a *fraction*, putting the dividend in the place of the numerator, and the divisor in that of the denominator. Thus $\frac{a}{b}$ is a divided by b.

27. When four quantities are *proportional*, the proportion is expressed by points, in the same manner as in the Rule of Proportion in arithmetic. Thus $a:b::c:d$ signifies that a has to b the same ratio which c has to d. And $ab:cd::a+m:b+n$ means that ab is to cd as the sum of a and m to the sum of b and n.

28. Algebraic quantities are said to be *like* when they are expressed by the same *letters*, and are of the same *power*; and *unlike* when the letters are different, or when the same letter is raised to different powers. Thus ab, $3ab$, $-ab$, and $-6ab$, are like quantities, because the letters are the same in each, although the signs and co-efficients are different. But $3a$, $3y$, $3bx$, are unlike quantities, because the letters are unlike, although there is no difference in the signs and co-efficients. So x, xx, and xxx, are *unlike quantities*, because they are different powers of the same quantity. (They are usually written x, x^2, and x^3.) And universally if *any quantity is repeated as a factor* a number of times in one instance, and a *different* number of times in another, the products will be *unlike quantities*; thus, cc, $cccc$, and c, are unlike quantities. But if the same quantity is repeated as a factor the *same number* of times in *each instance*, the

(6) If a quantity be both *multiplied* and *divided* by another, the value of the former will not be altered.

(7) Quantities which are respectively equal to any other quantity, are equal to each other.

(8) The whole of a quantity is greater than a part.

(9) The *whole* of a quantity is equal to *all its parts*.

ENGLISH.—XIX.

[*Continued from Vol. III., p. 363.*]

SUFFIXES (*continued*).

Etiquette means a "little ticket," and originally denoted the short inscriptions or tickets put on packages of goods to point out what they contained. But similar etiquettes or tickets were employed to declare certain observances required in a public assembly; and so the word came to signify *forms* and *formalities*, a strict regard to custom; and in general, social conventionalism, particularly in relation to behaviour.

Eur is a French termination—*e.g.*, vend*eur*, *a seller*; prodit*eur*, *a betrayer*. It is similar in meaning to our ending *-er*, and denotes an agent. Of old, many English words now terminating in *-or*, terminated in *-eur*; as auth*eur* for auth*or*. The termination is still retained in certain nouns denoting abstract qualities; for instance, grand*eur* (Latin, grandis, *great*); haut*eur* (French. haut, *high*), derived immediately from the French. The notion of the agent is retained in the French douc*eur* (from the French doux, *sweet*), *a sweetener; a fee* or *bribe*.

Full, of English origin, obviously the same as the adjective *full*, gives an instance of the origin of these particles in words which originally had a definite form and signification. According to its root-meaning, *full* (now in combination written *-ful*) denotes abundance of the quality indicated by the word to which it is affixed; as hate, hate*ful*; thank, thank*ful*; grate*ful*, delight*ful*. *Full* has for its opposite *-less* (q.v.); for example, merci*ful*, merci*less*. In the employment of words, you cannot follow analogy alone, but must consult usage; thus, you may say penni*less*, but you cannot say penni*ful*; yet piti*ful* is as good as piti*less*. Though *-ful* is of English origin, it is added to many words of Romance derivation—*e.g.*, merci*ful*, bounti*ful*, etc.

> "How oft, my slice of pocket store consumed,
> Still hungering, *pennyless*, and far from home,
> I fed on scarlet hips and stony haws."
>
> *Cowper*, "*Task*."

Fy is from the Latin facio, *I make*. It is seen in fructi*fy*, lit. *to make fruit*; that is, *to make fruitful*.

> "Calling drunkenness, good-fellowship; pride, comeliness; rage, valour; bribery, *gratification*."—*Bishop Morton*.

Head or *-hood* is an English suffix, and denotes the *essence* of any person or thing; its essential conditions, viewed as a whole. Thus: man*hood*, wife*hood*, woman*hood*, child*hood*, brother*hood*, priest*hood*.

> "Canst thou, by reason, more of *godhead* know,
> Than Plutarch, Seneca, or Cicero?"
>
> *Dryden*, "*Religio Laici*."

Ible. (*See -able*, formerly explained under suffixes.)

Ic is a Romance suffix corresponding to the Latin termination *-icus*: as, soporif*ic*, rust*ic*. In substantives of Greek origin denoting science or art, or their professors, a similar suffix is found: *e.g.*, arithmetic, logic, cleric, etc.

> "Fool, thou didst not understand
> The *mystic* language of the eye nor hand."
>
> *Donne*.

Ical, an adjective ending, from the Latin *-icalis*, For example, am*icalis*, am*ical* (friendly), gramma*ticalis*, grammat*ical*; so crit*ical* (Greek κρίνω, I judge), which is only the noun crit*ic* with the suffix *-al*; so mus*ical*, mus*ic*, myst*ical*, myst*ic*. In the three last instances the Latin ending has been added to Greek words, so that they are hybrids.

Ile, from the Latin adjective termination *-ilis*, to be seen in doc*ilis* (Latin *doceo*, I teach), *docile*, frag*ilis* (Latin *frango*, I break), *fragile*.

In, *-ine*, is from the Latin termination *-inus*, which denotes sometimes a name, as Tarent*ine*, an inhabitant of Tarentum, but in English more often a quality, as genu*ine*, from the Latin genu*inus*, which is derived in its turn from genus, *a kind* or *race*—that is, that which possesses the qualities belonging to its kind, in opposition to spurious, which, in its Latin meaning, signifies a *bastard*.

> "We use
> No foreign gums, nor essence fetched from fa
> No volat*ile* spirits, nor compounds that are
> Adulterate; but as Nature's cheap expence
> With far more genu*ine* sweets refresh the sense."
>
> *Carew*.

Ing is an English suffix, and signifies *son*, as Edgar Athel*ing*—that is, *Edgar, the son of Athel*, or *Edgar of noble blood*. In English, *-ing* forms the ending of our active participles, as sing*ing*, from *to sing*; also a very large class of nouns; thus, sing*ing* itself may be employed as a noun, as, *the singing was good*. These nouns, as might be expected from the meaning of the Saxon *-ing*, denote existence; thus, *to sing* is a verb, but sing*ing* is the active of

the verb in actual being. When these words in *-ing* are used as nouns, they should have the government of nouns: thus, *the singing of the birds was delightful*. Almost every English verb may be made into a noun by the suffix *-ing*: to eat, the eat*ing*; to diminish, the diminish*ing*; to run, the runn*ing*. Observe that the idea of activity is connected with nouns ending in *-ing*; as, the see*ing*, the hear*ing*, the danc*ing*, the report*ing*—that is, the act, the process of danc*ing*, report*ing*, etc.—wherein those nouns differ from other nouns which express the result of an action: as *sight*, the result of the act of see*ing*; *report*, the result of the act of report*ing*.

Ion, from the Latin termination *-io*; as actio, *action*; quæstio, *question*; motio, *motion*; visio, *vision*. The majority of nouns in *-ion*, like nouns in *ing*, may be called verbal, seeing that they are derived immediately from verbs; as actio, from the Latin verb ago (participle passive actus), *I do*; motio, from the Latin verb moveo (participle passive motus), *I move*, etc. They do not all of them denote states or actions; some denote persons—*e.g.*, champion, companion.

Sometimes this suffix in English has another form, such as *-on*, *-eon*, *-oon*—*e.g.*, gallon, truncheon, poltroon.

Ique, from the Latin *-iquus*, as in *antique*. *Antiquus*, in Latin, means *ancient*; but ant*ique* does not mean ancient in a general sense. It most often is applied to that which is included within the limits of classical antiquity. Not seldom has antique the subordinate notion of *curious*, *singular*, or *odd* connected with it; probably because ant*iques* are rare.

> "Name not these living death-heads unto me,
> For these not ancient but *antique* be."—*Donne.*

> "And sooner may a gulling weather-spy,
> By drawing forth heaven's scheme, tell certainly
> What fashioned hats or ruffs, or suits next year,
> Our giddy-headed *antique* South will wear."—*Donne.*

The word *antic*, from *antique* (formerly spelt *antick*), takes its force from this associated notion of singularity.

> "We cannot feast your eyes with masks and revels,
> Or courtly *anticks*." *Shakespeare.*

> "Within the hollow crown
> That rounds the mortal temples of a king
> Keeps Death his court; and there the *antick* sits
> Scoffing his state." *Shakespeare.*

> "A work of rich entail and curious mold,
> Woven with *anticks* and wild imagery."—*Spenser.*

Ise, formerly *-ize*, of Greek origin; as in the word bapt*ise*, from the Greek βαπτίζω, pronounced bap-ti'-zo, *I dip frequently*. From the same Greek ending we have dogmat*ise*, method*ise*, critic*ise*. With this termination are connected the other suffixes *-ist*, *-ism*, *-istry*, seen in bapt*ist*, bapt*ism*, bapt*istry*. In bapt*ismal* you will notice that the Romance suffix *-al* is added to a word which is of Greek origin. It is therefore a *hybrid*, the meaning of which word has already been explained to you.

> "He (the pope) solicited the favour of England by sending Henry a sacred rose, perfumed with musk, and anointed with *chrism*."—*Hume.*

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While *-ism* denotes the sect, *-ist* denotes the sectary; as, Athe*ist*, De*ist*, Methodi*st*, etc.

The adherents to particular modes of faith are also designated by *-arian*; as, Trinit*arian*; Unit*arian*; or *-ian*, as Episcopal*ian*. Another form is found in *-ite*; as Irving*ite*, Mormon*ite*, etc. Analogy is a dangerous guide in English, for, while we say Irving*ite*, we DO NOT say Southcot*ite*, but Southcot*ian*—probably for the sake of the sound.

Ish, connected with the German *-isch* (as in mürr*isch*, peevish), denotes, as in peev*ish*, a quality, and so forms adjectives. *Ish* has sometimes a diminutive force; as thinn*ish*, thick*ish*. When forming part of verbs, as in pun*ish*, publ*ish*, *-ish* has a different origin.

Some verbs, which in Latin end in *-ire*, and in French in *-ir*, have the suffix *-ish* in England: But when we remember that the present participle of these verbs in French ends in *-issant*, we understand the presence of the *-ish* in English. Thus from *finir* (pres. part. *finissant*), we get fin*ish*.

Ite, a patronymic, or father-name—the name that is expressive of a race, like the Greek *-ides*—is very common in the Old Testament, from the language of which it may have come into the English; thus, Israel*ite* is *a descendant of Israel*; so we have Hitt*ites*, Hiv*ites*, etc.

Ive, of Latin origin, from *-ivus*, as seen in capt*ivus*, *a captive*; also in fugit*ive*, (Latin, fugio, *I flee*); nat*ivus* (Latin, natus, *born*), *a native*; vot*ivus* (Latin, votum, *a vow*), *votive*. This *-ivus* in French becomes *-if*, whence we have plaint*iff* (French, plaindre, *to complain*), the *complainant* in a suit in opposition to the defendant. Plaint*iff* and plaint*ive* are forms of the same word differently employed, as are also capt*ive* and cait*iff*. The suffix *-iff* is only found in nouns, while words in *-ive* are generally adjectives,

though there are exceptions (as fugitive, captive, etc.) to this rule.

"We were here entertained with an echo repeating a whole verse in a softer and more *plaintive* tone, indeed, but with surprising precision and distinctness."—*Eustace, "Italy."*

Ix. This Latin suffix denotes a feminine agent, as testatr*ix*. The masculine form is *-or* (q.v.).

Kin, the Anglo-Saxon cyn, *kin*, *offspring*, *son*, signifies the *son of:* as in Wil*kin* (Wilkins); seen in another form—namely, Wil*son*. Kin, from its signification, has also a diminutive force; as in lamb*kin* (a lamb's child), or *little lamb*. What is little is dear, hence diminutives are terms of endearment. But what is little may be despised. Sometimes, therefore, diminutives imply contempt; as in mani*kin*.

"This is a dear *manikin* to you, Sir Toby."—*Shakespeare.*

Le (*see El*), among the suffixes already given.

Less, the Anglo-Saxon læs (German, los, *destitute of*), has a negative force. It must be borne in mind that *less*, the comparative of little, is altogether a different word. Thus we are led to understand the true force of *-less* when employed as a suffix: as motion*less*, or *without motion;* death*less*, *free from death*.

Let is an English suffix, and has a diminutive force. It is found in stream*let*, tart*let*, ham*let*, etc.

Ling, of English origin, denotes *descent*, and hence offspring; also that which is little, and that which is beloved—*e.g.*, dar*ling* (*dear child*), gos*ling* (*little goose*), nest*ling*. Hire*ling* is properly a child of hire, a person whose services are obtained by hire. The idea of contempt which it sometimes conveys does not necessarily, for it did not originally, belong to the word.

"I will be a swift witness against those that defraud the *hireling* in his wages."—Malachi iii. 5 (compare Job vii. 1, 2; xiv. 6).

Strip*ling* may be connected with the Latin stirpes, stirps, *offshoot;* so that stripling is *a little branch*, *a youngster*.

"He is but an *yonglyng*,
A tall, worthy *stryplyng*."—*Skelton.*

"Now a *stripling* cherub he appears,
Not of the prime, yet such as in his face
Youth smiled celestial."—*Milton, "Paradise Lost."*

Ly, a termination of English origin, forming an adjective or an adverb: as *childly*, in German kind*lich;* *manly*, männ*lich*. When *-ly* is added to a noun, it forms an adjective, as love, love*ly;* when it is added to an adjective, it forms an adverb, as wise, wise*ly*. Such a formation as "holi*ly*" (1 Thess. ii. 10) is to be avoided, as the repetition of the same syllable has an awkward sound.

Ment corresponds with the Latin *-mentum* (as in orna*mentum*, *an ornament;* adju*mentum*, *an assistance*), and the French *-ment* (as in the French mandement, *a command*), and denotes the result of the act indicated in the verb from which the noun is derived: thus, velo means *I veil* or *cover;* and velamen or velamentum is *a veil* or *covering;* so ali*ment* (from the Latin alo, *I nourish*) is *a means of nourishing*, *nourishment*.

Mony, as in ali*mony*, sancti*mony*, a suffix of Romance origin. In Latin it is *-monia* (as in parsimonia, *sparingness*), which denotes a consequence, as in testi*mony*, the result of the act of testis, *a witness*.

Ness, as found in little*ness*, nothing*ness*, is an English suffix signifying the abstract quality. Examples: hard*ness*, great*ness*, light*ness*, heavi*ness*, etc. This suffix may be added to the majority of adjectives, though if the strict rule were followed it would not be added to Romance words.

Ock is an English suffix, and has a diminutive force, as in hill*ock*, which means *a little hill*. So bull*ock* originally meant *a young bull* or *calf*. Another form of bullock is bul*chin*, obviously bull's-*kin*, that is, *bull's child*, as in the Hebrew, "steer, the son of a bull," for a bullock or calf (Exod. xxix. 1; Lev. iv. 3).

"And better yet than this, a *bulchin*, two years old;
A curled pate calf it is, and oft could have been sold."
Drayton, "Polyolbion."

Oon, *see Ion.*

Or, a suffix which corresponds to the Latin *-or*, the French *-eur*. It denotes the agent. It is seen in auth*or*, Latin auct*or*, French aut*eur*. Many words introduced into English from the French had the suffix *-our*, but this form is fast becoming obsolete, though we still write fav*our*, not fav*or*, as they do in America.

"The *author* of that which causeth anything to be, is *author* of that thing also which thereby is caused."—*Hooker.*

"From his loins
New *authors* of dissension spring."—*Philips.*

Ory, a Latin suffix, seen in promont*orium*, a promont*ory* (pro, *forward*, and mons, *a mountain*); and auditory, from auditorium (audire, *to hear*).

Ose, from the Latin *-osus*, as mor*osus* (*ill-tempered*), morose. Another (and a commoner) form of this suffix is *-ous*, which may be compared with the French form *-eux* (fem. *-euse*). We have the ending in imperi*ous*, imperi*osus;* religi*ous*, religi*osus;* invidi*ous*, invidi*osus;* suspici*ous*, suspici*osus*.

Ote, of Latin origin, found in verbs formed from the Latin participle in *-otus;* as, to prom*ote*, from prom*otus* (*moved forward*); to dev*ote* (Latin, dev*otus*, *consecrated*—votum, *a vow*—something sacred or set apart for the gods).

"Such on Isis' temple you may find
On *votive* tablets to the life pourtrayed."—*Dryden.*

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The adherents to particular modes of faith are also designated by *-arian*; as, Trinit*arian*; Unit*arian*; or *-ian*, as Episcopal*ian*. Another form is found in *-ite*; as Irving*ite*, Mormon*ite*, etc. Analogy is a dangerous guide in English, for, while we say Irving*ite*, we DO NOT say Southcot*ite*, but Southcot*ian*—probably for the sake of the sound.

Ish, connected with the German *-isch* (as in mür*isch*, peevish), denotes, as in peev*ish*, a quality, and so forms adjectives. *Ish* has sometimes a diminutive force; as thinn*ish*, thick*ish*. When forming part of verbs, as in pun*ish*, publ*ish*, *-ish* has a different origin.

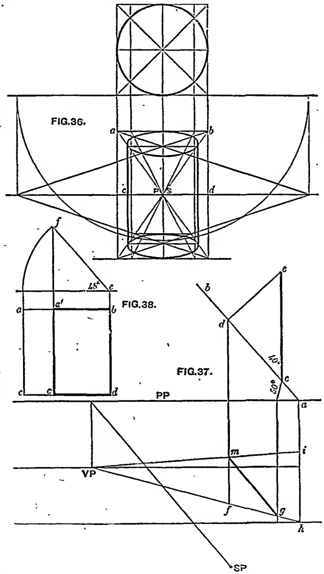
Some verbs, which in Latin end in *-ire*, and in French in *-ir*, have the suffix *-ish* in England. But when we remember that the present participle of these verbs in French ends in *-issant*, we understand the presence of the *-ish* in English. Thus from *finir* (pres. part. *finissant*), we get fin*ish*.

Ite, a patronymic, or father-name—the name that is expressive of a race, like the Greek *-ides*—is very common in the Old Testament, from the language of which it may have come into the English; thus, Israel*ite* is *a descendant of Israel*; so we have Hitt*ites*, Hiv*ites*, etc.

Ive, of Latin origin, from *-ivus*, as seen in capt*ivus*, *a captive*; also in fugit*ive* (Latin, fugio, *I flee*); nat*ivus* (Latin, natus, *born*), *a native*; vot*ivus* (Latin, votum, *a vow*), *votive*. This *-ivus* in French becomes *-if*, whence we have plaint*iff* (French, plaindre, *to complain*), the *complainant* in a suit in opposition to the defendant. Plaint*iff* and plaint*ive* are forms of the same word differently employed, as are also capt*ive* and cait*iff*. The suffix *-iff* is only found in nouns, while words in *-ive* are generally adjectives,

point draw a line to the respective V P; thus, if the line of contact is from *d*, D E will be its V P; a perpendicular line drawn from the centre of the circle to cut this vanishing line will be the axis, and the point of intersection will mark the apex, from which draw lines to *o* and *p* for the sides of the cone.

PROBLEM XVII. (Fig. 36).—*A cylinder 4 feet diameter and 8 feet high stands on its end; the eye is opposite half the height of the cylinder.* In working this problem we prefer placing the plan beyond the P P, it being necessary to draw a circle for each end of the cylinder, therefore the same perpendicular lines drawn from the plan will answer for both. It will be seen that when these perpendiculars have reached the base of the picture other lines are drawn from them to the P S, and the circle is drawn by hand as in Fig. 31, Vol. III., page 346. For the upper circle, *a b* is drawn horizontally across the perpendiculars according to the height of the cylinder, and the same process with regard to the circle is followed as in the one for the base; lastly, lines *c*, *d*, drawn tangential to the outer edges of the circles, will give the sides of the cylinder.



PROBLEM XVIII. (Fig. 37).—*To draw the perspective representation of an incline. A rod 5 feet long is inclined to the horizon 40°. The plan of the rod is 50° with the picture plane, the nearest end 1 foot from it.* In this case the vanishing point of *the plan* of the rod must be found, *and not that of the rod itself.* We intend in a future lesson to show how the vanishing point for an incline may be found without a plan, giving only the dimensions and positions, and the method of using it; but for the present turn back to Problem IV., Fig. 14 (Vol. III., p. 280), where the same subject is shown in orthographic projection; the rod is there placed at a given angle with the ground, *x y*, and perpendiculars are drawn from the extremities between which the line *a b*, the plan, is drawn. Now we must first project the rod orthographically in order *to determine the plan* preparatory to drawing it perspectively. An indefinite line *a b* must be drawn at an angle of 50° with the picture plane; *c* is the point where the rod touches the ground, draw *c e* 5 feet long at an angle of 40° with *a b*; draw *e d* perpendicularly to *a b*; *c d* will then be *the plan* of the rod; complete the perspective representation of *c d*, which will be *f g*. (*See* Fig. 7, lesson II., Vol. III., p. 218.) The last observation refers to *the perspective only of the plan*; we must now represent the rod in its inclined position. As one end of the rod is on the ground, and the other above it, our attention must be directed to the elevated end, because the lower end is already found in *g*. It must be evident, on turning once more to Fig. 7, that the line *f g* is the perspective of the line *d c*; and since the line *d c* is the plan of the given line *e c*, therefore *e* must be perpendicularly over *d*. The question now

Ric, as in bishop*ric*, in Anglo-Saxon denotes *power*, *dominion*, *territory*, and is a hybrid word; *bishop* being derived from the Greek. Bishop*ric*, then, is the *jurisdiction of a bishop*.

Ship is an English suffix, and is of the same origin as the Anglo-Saxon *-scipe*, the German *-schaft*, denoting *a state*, *an office*, *a dignity*: as, freond-scipe, *friendship*, *the state of being a friend*; in German, freund*schaft*.

"My train are men of choice and rarest parts,
That all particulars of duty know;
And in the most exact regard support
The *worship* of their names."—*Shakespeare.*

Hence "worship" is a title of honour.

"Dinner is on table; my father desires your *worship's* company."—*Shakespeare.*

"Under the name of church, I understand a body or collection of human persons, professing faith in Christ, gathered together in several places of the world for the *worship* of the same God, and united into the same corporation."—*Pearson.*

Some is an English suffix found in adjectives. In Anglo-Saxon it was *-sum*, as winsum, *winsome*, that is, *winning*. We find the termination in lone*some*, hand*some*, tire*some*, etc.

Ster, an English suffix denoting the *feminine gender*, as spinster, a female spinner. The following list will show the real meaning of nouns ending in *-ster*:—

MASCULINE.	FEMININE.
Sangere, *a singer*;	Sangestre, *a songster*.
Bacere, *a baker*;	Bacestre (Baxter), *a female baker*.
Fidelere, *a fiddler*;	Fidelstre, *a female fiddler*.
Vebber, *a weaver*;	Vebbestre (Webster), *a female weaver*.
Rædere, *a reader*;	Rædestre, *a female reader*.
Seamere, *a seamer* (*sewer*);	Seamstre, *a seamstress*.

Nouns ending in *-stress* are double feminines. That is to say they have the English feminine suffix *-ster*, to which is added the Romance suffix *-ess*. Such doubles are songstress, seamstress, etc.

"Through the soft silence of the listening night,
The sober-suited *songstress* trills her lay."—*Thomson.*

Th, an English suffix. The addition of *-th* to adjectives transforms them into nouns, as tru*th*, from true. We find the ending in mir*th* (merry), dear*th* (dear), bread*th* (broad), dep*th* (deep), etc.

Tude, a Latin termination, found in lati*tudo* (latus, *broad*), *latitude*; longi*tudo* (longus, *long*), *longitude*. So forti*tude* (fortis, *brave*), magni*tude* (magnus, *great*), etc.

Ty is a Romance suffix which is found in Latin as *-tas*, in French as *-té*, as authori*ty*, beau*ty*, hones*ty*, commodi*ty*.

Ule, a Romance diminutive suffix. It is seen in glob*ule*, from the Latin glob*ulus*, *a small globe* or *ball*. The termination *-ule* (in Latin both *-ulus* and *-ula*) is also found in partic*ule* (Latin particula) shortened into parti*cle*. Animalcule, *a little animal*, is formed by analogy rather than authority, inasmuch as the only connected diminutive in Latin is anim*ula*, from anima, there being no diminutive from *animal*.

Ure, from the Latin *-ura*; as tinct*ura* (a colour), tinct*ure*. It is found also in verd*ure* (Latin, viridis, *green*), immediately from the French; and in ten*ure*, from the word *tenura*, belonging to feudal or mediæval Latin.

Ward corresponds to the German *-warts*, as in vorwärts, *forwards*. It forms many compounds, traces of which are found in the Anglo-Saxon, as thither-weard, *thitherward*; ham-ward, *homeward*. In the use of *toward*, the *to* and *ward* were sometimes separated by the interposition of the noun under regimen, as in 1 Thess. i. 8—

"Your faith *to* God-*ward* is spread abroad."

Wise, from the Anglo-Saxon wise, *manner*, is used in both Anglo-Saxon and English as a suffix: as right*wis*, *righteous*, formerly *rightwise*; unright*wis*, *unrighteous*. Wise, denoting *manner*, is found in the Bible.

"Now the birth of Jesus Christ was on this *wise*." (Matt. i. 18.)
"If thou afflict them in *any wise*." (Exod. xxii. 23.)

In some words *-ways* is found as a suffix instead of -wise, as in length*ways*. Good writers use *longways* no less than *longwise*. *Sideways* is common, while *sidewise* is never met with. For always, *algates* was once used; and for otherwise, *othergates* (which are the same as our always and otherways; *gates* being connected with the German gehen, *to go*, and gasse, *a street* or *way*). These words are still not uncommon in the north of England.

Y, a Saxon termination, in adjectives representing *-ig*, as myr*ig*, merr*y*; wässer*ig*, water*y*; and in nouns representing the Latin *-ia*, as victor*ia*, victor*y*; for the Greek, also, *-ia*, as geometr*ia*, geometr*y*. See the terminations *-ance* and *-ce*.

GEOMETRICAL PERSPECTIVE.—IV.

[*Continued from Vol. III., p. 348.*]

PROBLEMS XVI.—XXIII.

PROBLEM XVI.—*A cone 4 feet diameter and 6 feet high.* This will be done from almost the same directions as the pyramid. Look back to Problem XII., Fig. 31, Vol. III., page 346, where we have the perspective of a circle. Now the base of the cone, being a circle, must be treated in the same way. To draw the elevation, draw a perpendicular line, the line of contact from *d* or *b* (Fig. 31); mark off upon this line the given height. and from that

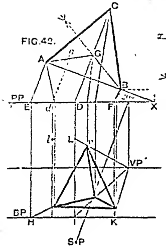


FIG.42.

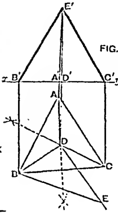


FIG.43.

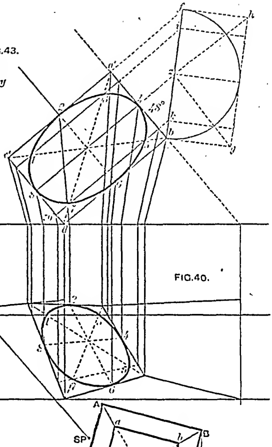


FIG.40.

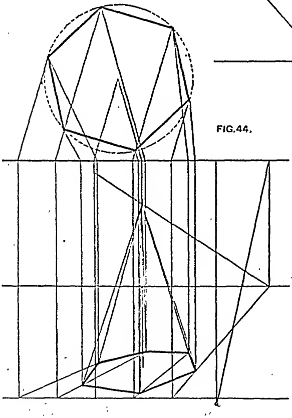


FIG.44.

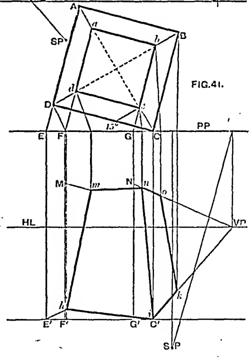


FIG.41.

given with Figs. 38 and 39 will be sufficient to clear all difficulties with respect to the board only. As the circle is lying on the board or inclined plane, the end or profile of which is fb, we must ascertain *the whereabouts of the points* through which the circle is drawn upon the incline. Let the pupil draw a square on a separate piece of paper, and describe within it a circle, then hold the paper at an angle with the horizon, the inclined edge being opposite the eye; he will first see how from an inclined line we can represent the whole of a square, as illustrated by Figs. 38 and 39; but in this case we have the addition of a circle within the square, therefore the points through which the circle is drawn must be brought to the edge of the inclined square represented by the line fb (Fig. 40). A semicircle will be sufficient to help us in this, as the opposite portions of the circle and the several points through which it passes correspond; therefore the method of construction above given will enable us to produce *upon the plan of the board the plan of the circle also.*

To proceed with the perspective representation, let the pupil draw visual rays from all the points in $c'd$ and $a'b$, to cut the respective sides of the perspective projection of the square; draw lines between the corresponding points on the opposite sides of the perspective square, and also the diagonal lines of the square: the points through which the circle is to be drawn by hand will be those which are found to answer to the same in the ground plan.

PROBLEM XXI. (Fig. 41).—*A truncated pyramid has a square base of* 1·5 *inch side, the top is of* 1 *inch side, the height* 2·5 *inches. Give a perspective representation of the pyramid resting on a horizontal plane with the plan of the picture inclined to one of the edges of the base at an angle of* 15°. *The line of sight to be* $\frac{2}{5}$ *of the height of the pyramid.*

After placing the line C D (an edge of the base) at the given angle, 15° with the P P, draw the plan according to the instructions given in Problem VI. (Vol. III., p. 280). Here is an instance where the use of one V P only will be absolutely necessary; there are two sets of retiring lines, viz., C D and its parallels, and C B and its parallels; if we were obliged to determine the V P for C D and its parallels, we should find by drawing from the station point a parallel to C D that the V P would be at a very considerable and inconvenient distance out of the paper; therefore produce the parallels to C B, viz., A D, $a\,d$, and $b\,c$, to the P P in the points E F G; determine the V P for these lines only, and follow the instruction given with reference to Figs. 27, 28, and 29 (Vol. III., p. 344) in drawing the perspective of the base; the points of contact E and C will be the points to be brought down to E′ and C′ for the base. The lines of contact from F and G must also be brought down to the base of the picture upon which to measure *the height of the pyramid* F′ M and G′ N. Divide F′ M or G′ N into three equal parts, and through the second from the base draw the line of sight parallel with the P P. Find the V P. to which draw lines from the points of contact E′ and C′; these lines cut by visual rays from D and B in the plan will decide the extent of the base in $h\,i$ and k. For the top lines must be drawn from M and N to the V P, and cut by visual rays from the plan of the top, as was done with the base; draw the inclined edges $m\,h$, $n\,i$, and $o\,k$; this will complete the subject.

PROBLEM XXII. (Fig. 42).—*Supposing an equilateral triangle, having its side* 2·5 *inches, to be the base of a pyramid* 2·5 *inches high, draw a perspective representation of the pyramid. Assume one side of the base to be inclined at an angle of* 20° *with the picture plane, the nearest edge of the pyramid to be* $\frac{1}{2}$ *inch from the picture plane, and the observer's eye to be* 5 *inches from the picture plane, and* 1·5 *inch above the horizontal plane on which the pyramid stands, and opposite a point* 2 *inches to the left of the angle of the pyramid nearest the picture plane.* (From a Military Examination Paper.)

Draw a line, A X, at an angle of 20° with the P P, determine the point B $\frac{1}{2}$ inch from the P P, and make A B equal 2·5 inches, upon which describe an equilateral triangle, the base of the pyramid. The centre of the triangle must be found by bisecting two of the angles (or by bisecting two of the sides, because the figure is a regular one, having equal angles and equal sides); the intersection of the bisecting lines will be the centre at G, which is *the plan of the apex of the pyramid.* Produce the line C G to D, and draw from A and B parallel lines to meet the P P in E and F. From E, D, and F draw perpendicular lines to the base of the picture B P. Place the station point (S P), and draw the H L according to the given distance stated in the question; find the V P for D G C, which will also be the V P for the other parallel lines drawn from the plan to the P P: visual rays drawn from A, B, C, and cutting other lines drawn from H I K to the V P, will at their intersections give the perspective positions of the several angles of the triangle, which must be completed by straight lines forming these angles. Thus far there is no particular difference in the rule for drawing the perspective of the base from the one given for the last problem and several others gone before; but we wish especially to draw the attention of our pupils as to which of the lines of contact E H, D I, or F K must be the one upon which the elevation or height of the pyramid is to

be set off. It will be easily understood, when we consider that *the vertex of the pyramid is over the centre of the base, that the line of contact connected with the centre must be the one*, viz., D I. Therefore upon D I mark the height of the pyramid, viz., I L; from L draw a line to the V P, and a visual ray from G cutting this line in M will give the position of the vertex of the pyramid. Draw from M lines to meet the angles at the base, which will complete the representation required. Suppose the three inclined faces had not been equal, and that the plan of the vertex had been at *g*, then *g d* must be drawn parallel to G D, the line of contact brought down, and from the height measured to *l* a line drawn to the V P, and the visual ray from *g* to cut this line, to find the vertex from which intersection the edges drawn to the angles at the base as before will represent the pyramid.

Suppose the solid to be a regular tetrahedron, that is, a figure with four equal faces, each face would then be an equilateral triangle; *the height in this case would have to be found.* This obliges us to have recourse to *geometrical or orthographic projection.* Upon a little reflection the pupil will see that the distance of the vertex from the ground will be *less* than the length of the edge of the pyramid; first, because a straight line drawn from an angle of the equilateral triangle to the centre of the opposite side is less than the side; and again, it would be further reduced because the triangular face is inclined. Now how much the height may be less than the edge can be determined by the following mode of proceeding:—Let A B C (Fig. 43) be the plan of the pyramid at the base, and D the plan of the vertex. Now it is understood that all the faces of this solid are equal, and that they are equilateral triangles. Again, we have the full extent of each of the triangles represented by that of the plan A B C, therefore we know the length of the edges of the inclined triangles, of which A B D is the plan of one, B D C of the second, and A D C of the third. Of course the vertex of the pyramid will be perpendicularly above its plan in the centre D, therefore *we must rabat the perpendicular*, that is, turn it down upon the paper, and thus form the right angle B D E. From B with the distance B A or B C cut the perpendicular D E in E join B E, which will represent the rabatted and inclined edge of the pyramid, whilst D E will represent the height of the pyramid. We may, perhaps, make it clearer in this way:—that as the line B D must be the plan of an inclined edge of the triangle A B D, of which B D is the plan, and because B E, the rabatted edge, is equal to B A, and D E perpendicular to D B, therefore D E must be equal to the height of E, the vertex from the ground. To represent the elevation draw B B′, A A′, and C C′, at right angles with *x y* (the axis of the plane of projection), produce D D to any length and make D E′ equal to D E; draw from E′ lines to B′, A′, and C′, which will represent the vertical projection or elevation of the pyramid. To draw the plan, and ascertain the height of the pyramid by the rabatment of the right-angled triangle B D E, will be all that is necessary to prepare the subject for the perspective representation. We have added the orthographic elevation, trusting it may assist the pupil to understand *that the height is not equal to one of the edges.*

To proceed with the *perspective elevation*, draw the plan as in Fig. 42, find its height by Fig. 43, and set off that height from I to L (Fig. 42). For the rest proceed as in Fig. 42. We will give another question similar in character to the last problem, for the pupil to work out by himself, without any accompanying explanation except the figure.

PROBLEM XXIII. (Fig. 44).—*Give a perspective view of a regular pyramid on an hexagonal base, the height of the pyramid being equal to three times the length of one of the edges of its base. Assume that it is seen from a point to the right of it, and at a height above the horizontal plane equal to ½ the height of the pyramid.*

We will merely add that as no definite scale is given with the above problem, the pupil can please himself as to the size, only he must take care to observe *the proportions* mentioned. The expression "the horizontal plane" means the ground upon which it stands.

BOTANY.—IX.

[*Continued from Vol. III., p. 350.*]

THE INFLORESCENCE (*continued*)—ITS SYMMETRY—THE FLORAL ENVELOPES.

WHERE all the parts in each floral whorl are similar in size and shape, the flower can be divided by several radiating planes of symmetry, and is called *polysymmetric:* where, from inequality of size or difference of form of the parts in any one whorl, the flower can only be divided by one such plane, it is *monosymmetric.* Polysymmetric flowers are often termed *regular*, and, in some works, *actinomorphic*, or star-shaped; and monosymmetric ones are termed *zygomorphic*, or with parts in pairs, or somewhat inappropriately *irregular.* Flowers are occasionally truly irregular or *asymmetric*, when not symmetrically divisible in any plane. The primitive type or original form of flower in every large group would seem to have been polysymmetric.

Almost all the modifications by which flowers depart from the typically simple condition of four

or five whorls of similar, separate organs, three, five, or two in a whorl, may be explained as due either to *cohesion*, *adhesion*, *abortion*, *suppression*, *chorisis*, or unequal growth. *Cohesion* is the union of like parts, as sepals to sepals, petals to petals; *adhesion*, the union of dissimilar parts, as stamens to petals. Though there are cases, such as the stamens of *Compositæ*, united by their anthers only, where structures originally distinct do afterwards cohere, nearly all cases of so-called cohesion and adhesion in the flower are really due to growth of the receptacle, generally in more or less peripheral rings, intercalated below the organs appearing to be united and so carrying them up on a common base. Cohesion will, in such cases, mean the *intercalary growth* of the receptacle below a single whorl; adhesion, similar growth below two contiguous whorls. Thus when the sepals appear distinct, as in buttercup, the calyx is commonly called *polysepalous* (or otherwise *dialysepalous* or *eleutherosepalous*); when they appear coherent, as in pinks, it is called *gamosepalous* (or *synsepalous*), this being due to the growth of a *calyx-tube* or tubular outgrowth from the receptacle below the sepals. It is, therefore, perhaps preferable to call all such tubes *receptacular tubes*. Similarly the corolla may be *polypetalous*, as in buttercup, or *gamopetalous*, as in heaths. The stamens may be distinct, or may all be united, as in furze or mallows, in a tube at the base of their filaments, when they are termed *monadelphous* ("in one brotherhood," Greek ἀδελφός, *adelphos*, a brother). When, however, the stamens are not all united in one tube, but appear to be coherent in several groups (*polyadelphous*), as in the orange and St. John's-worts (Hypericum), the structure can be shown by the study of the development of the flower in the bud stage to be really due not to cohesion of many stamens into a few groups, but to the branching (*collateral chorisis*) of an originally small number of stamens. In the mallows we have both branching and, as we have just seen, "cohesion," there being at first only five stamens, on which numerous branch-stamens appear, the whole mass being then carried up by intercalary growth. The carpels, if more than one be present, may be distinct or *apocarpous*; or coherent or *syncarpous*. In many plants, the zone of intercalary growth extending under both the corolla and the stamens, the latter appear united below to the former, and are called *epipetalous*. This is a case of adhesion. In many other plants, sepals, petals, and stamens are all carried up on a receptacular tube round the gynæceum without adhering to it. They are then termed *perigynous* (Greek περί, *pĕri*, around) or—the tube having been formerly called a calyx-tube—*calycifloral*. The adhesion may go a step farther so that the carpels become enclosed in an adherent receptacular tube, and the sepals, petals, and stamens appear to spring from the top of the ovary. The calyx is then called *superior*, the petals and stamens are still calycifloral but *epigynous* (Greek ἐπί, *ĕpi*, upon), and the carpels are *inferior*. The correlative terms superior and inferior, as applied to the calyx (or, more accurately, receptacular tube) and gynæceum, refer, in fact, less to position than to adhesion. If the gynæceum is free from the receptacular tube, even if low down in its hollow, as in the rose, it is superior; and whenever one of these two structures is superior, the other is inferior.

If organs are present, but in an imperfect condition, they are said to be *aborted*; whilst if, though present in allied forms and requisite to complete the typical symmetry, they are altogether absent, they are said to be *suppressed*. For instance, in the *Solanaceæ* or potato tribe the flowers are polysymmetrically pentamerous, with, therefore, five stamens; whilst in the allied order *Scrophulariaceæ*, the snapdragon tribe, the flowers are monosymmetric, and though the genus *Pentstemon* has five stamens, most of the other genera have four, as has the allied order *Labiatæ*, but *Veronica* has only two. This is suppression. Among *Labiatæ*, whilst most genera have four stamens, two long and two short, *Salvia* has only two producing pollen, the other two being mere rudiments, or *staminodes*, without function. This is abortion.

Actual multiplication of the number of floral whorls (*pleiotaxy*) may occur either in wild flowers or under cultivation, being one of the modifications known as *doubling*, as, for instance, in the bachelor's-button (*Ranunculus*) or in *Rosa centifolia*. As we have already seen, there are very often two whorls of stamens, as in the *Liliaceæ* and *Amaryllidaceæ*, being double the number of parts in either the calyx or the corolla; and such flowers are known, therefore, as *diplostemonous* (Greek διπλόος, *diplŏŏs*, double), those with a single whorl being termed *isostemonous* (Greek ἴσος, *isŏs*, equal). Increase in the number of parts (*pleiomery*) is, however, also largely due to a branching of the floral leaves, known as *chorisis* (Greek χωρίζω, *chōrizō*, I divide), often occurring very early in their development. This may occur in two ways, *collateral* or *co-radial*, the branches in the former case being side by side or in the same whorl, that is, and in the latter being on the same radius of the flower, *i.e.*, superposed, one in front of the other. One of the most familiar instances of collateral chorisis is the two pairs of long stamens in the flower of *Cruciferæ*, each pair, as is clearly seen in sea-kale.

being due to branching of a single stamen. Coradial chorisis is exemplified by the petals in double columbines (*Aquilegia*) and by double daffodils. Both methods may occur together. When, as we have seen, the stamens appear as if coherent in several groups (*polyadelphous*), as in the orange, each group is really a branched stamen, and the "indefinite" stamens of *Malvaceæ* are due to the branching of five original ones.

Cohesion, adhesion, and even chorisis will often not interfere with the polysymmetric character of the flower; but abortion, suppression, and the irregular growth of individual members in a whorl will commonly do so.

Many facts as to floral structure and symmetry can be conveniently represented for comparison in whether the ovary be superior or not in the diagram.

Many of the facts expressed by diagrams can also be expeditiously represented in *floral formulæ*. In these figures before the first full stop refer to the sepals; between the first and second, to the petals; between the second and third, to the stamens; and after the third, to the carpels. Round brackets, (), indicate cohesion; square ones, [], adhesion; a line above or below the last figure shows the ovary to be inferior or superior; a dagger indicates abortion; zero (0), the suppression of a whorl; the mathematical symbol for infinity (∞), the presence of more than 20 parts in a whorl; plus (+), the occurrence of more than one whorl of any one kind of floral leaves; the multi-

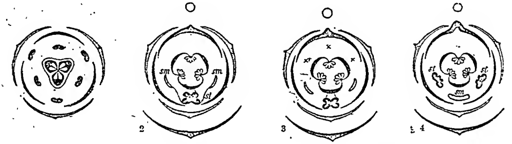


Fig. 51.—1, LILIACEÆ OR AMARYLLIDACEÆ; 2, 3, ORCHIS; 4, CYPRIPEDIUM.

a *floral diagram* or diagrammatic ground-plan. The parts in each whorl are represented in a circle, and cohesion, abortion, suppression, branching, and most adhesion can be readily expressed.

Plants in one Natural Order will commonly have identical, or nearly identical, diagrams, and more remote relationships are clearly indicated. Diagrams may be either *empirical*, merely stating the facts, or *theoretical*, filling in suppressed parts in accordance with a type. Thus the empirical diagram of *Orchis* (Fig. 51, *2*) shows one stamen (*st.*) and two staminodes (*sm.*); a theoretical one (*3*) shows the position of three others (×) necessary to complete the two staminal whorls, but only recognisable by their fibro-vascular bundles in the base of the flower; the allied genus *Cypripedium* (*4*) has two pollen-bearing stamens (*st.*) occupying the position of the staminodes of *Orchis*, and a staminode (*sm.*) in place of its one stamen; whilst these diagrams suggest a relationship to *Iris* (Fig. 52), in which the carpels are superposed upon the one whorl of stamens present, probably from the suppression of an inner whorl, and more remotely to the fifteen parts in five whorls in *Amaryllidaceæ*, with an inferior ovary, or in *Liliaceæ*, with a superior one (Fig. 51, *1*). It is difficult to show plication sign (×), branching; a waving line ($\sim$) over a figure, spiral arrangement; the signs $\rightarrow$ and $\downarrow$ before the formula, monosymmetry in the transverse and in the median plane respectively; I before the number representing any whorl, that it is superposed on the preceding one; and X that its parts are diagonally arranged. Thus the diagrams, Fig. 51, *2*, *3*, and *4*, would be represented by the formulæ:—

Fig. 52.—IRIS.

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In general descriptions of a flower it is only necessary to say in a word if it is incomplete, imperfect, or not polysymmetric, and to state its odour and approximate diameter. It is difficult to determine where the perfume of a flower resides, so it is attributed to the whole flower; and, as the test of a

good description is that an artist understanding the terminology, but not knowing the plant described, can make a drawing of it from the description, size is an important point. The order of development of the parts, and any physiological peculiarities, are similarly not so essential.

THE RECEPTACLE.

To consider the various parts of the flower separately, we will first examine the receptacle, *thalamus* or *torus*. Though its internodes are not generally so, they are sometimes elongated. In *Lychnis Flos-Jovis* that between the calyx and corolla is so, and is called an *anthophore* (Greek ἄνθος, *anthos*, a flower; φορά, *phora*, carrying). In the passion-flowers, that between the corolla and stamens is elongated, forming what is termed a *gynandrophore* as supporting both andrœcium and gynæceum. In the caper (*Capparis*) the internode between the stamens and the ovary is much produced, forming a *gynophore*; and, though it is very exceptional to have two of these elongated internodes in one flower, in *Gynandropsis*, belonging to the caper tribe (*Capparidaceæ*), there is both a gynandrophore and a gynophore. Finally in the mallow, spurge, maple, and especially umbelliferous and geranium families the axis is prolonged between the carpels as a *carpophore*. In the *Umbelliferæ* this is often bifurcate or Y-shaped, and in *Geraniaceæ* it forms the long five-fluted column with the styles of the carpels in its flutings, to which the genera owe their names of crane's-bill (*Geranium*), stork's-bill (*Pelargonium*), and heron's-bill (*Erodium*). Other modifications of, and outgrowths from, the receptacle within the flower are known as the *disk*. These are often fleshy cup-like or ring-shaped bodies, frequently glandular and excreting honey, and are thus among the structures known collectively as *nectaries*. Thus in the *Victoria regia* water-lily the receptacle grows up round, and imbeds the (inferior) ovary, and carries up calyx, corolla, and stamens on an *annular* or ring-shaped disk, making them strictly *perigynous*. In mignonette (*Reseda*) is a fleshy one-sided plate within the corolla bearing the stamens and ovary, and thus *hypogynous*; in *Citrus* is a cushion-like mass below the ovary; in the peony the disk forms a cup enclosing the carpels; in *Alchemilla* there is a fleshy perigynous ring round the inside of the "calyx tube;" and in the *Umbelliferæ* the receptacle besides imbedding the carpels extends over them as an *epigynous* disk bearing the petals and stamens. In other cases the disk is only represented, as in *Cruciferæ*, by separate glandular outgrowths on the receptacle.

It will have been noticed that it is mainly upon the receptacle that what is inappropriately termed the *insertion* of the various floral leaves, a point of primary importance in the classification of both Dicotyledons and Monocotyledons, depends. Thus if sepals, petals, stamens, and carpels spring one beneath the other from the more or less conical receptacle, as in buttercup, the calyx is *inferior*, the corolla and stamens are *hypogynous* (Greek ὑπό, *hupo*, under; and γυνή, *gunē*, a woman) and the gynæceum is *superior*. If the calyx, corolla, and stamens are carried out from under the gynæceum by a discoid horizontal extension of the receptacle, as in the flowers of the bramble (*Rubus*) or strawberry (*Fragaria*), or if they are carried up on a tube which does not adhere to the gynæceum, as in the plum (*Prunus*) or rose (*Rosa*), the calyx is inferior, corolla and stamens *perigynous*, and gynæceum superior. If, as in the flowers of apples, pears (*Pyrus*), medlars (*Mespilus*), or hawthorn (*Cratægus*), this receptacular tube does adhere to the sides of the ovary, the calyx becomes *superior* and the ovary *inferior*, the corolla and stamens remaining *perigynous*. If, lastly, as in *Umbelliferæ* and *Compositæ*, this adhesion or imbedding of the carpels extends upward so as to carry sepals, petals, and stamens over on to the top of the ovary, the calyx is superior, the corolla and stamens are *epigynous*, and the ovary is inferior.

THE PERIANTH.

In comparatively few families is the flower *achlamydeous* or without any perianth or floral envelopes. Though it is so in our common ash (*Fraxinus excelsior*), it is not so in allied species, such as the so-called flowering ash (*F. Ornus*) of southern Europe. In many more cases is there only one perianth whorl, *i.e.*, the flower is *monochlamydeous*. In most *Compositæ* the calyx is, properly speaking, absent, there being a tubular portion, truly a receptacular tube, but no sepals; and in many other cases, *Urticaceæ*, *Chenopodiaceæ*, *Polygonaceæ*, and several *Ranunculaceæ*, such as the marsh-marigold (*Caltha*), for instance, the corolla is absent. The term *perianth* is most commonly employed in these cases where there is but one whorl of perianth-leaves, or where, as in many Monocotyledons, both whorls are present, but closely resemble one another. In lilies, tulips, *Narcissus*, etc., both whorls are *petaloid*: in rushes they are *herbaceous* or leaf-like, or *glumaceous*, *i.e.*, dry and membranous or chaff-like. If the leaves of the perianth are distinct, it is *polyphyllous*, as in *Tulipa*; if coherent, it is *gamophyllous*, as in the lily-of-the-valley (*Convallaria*).

Æstivation.—Just as the folding of foliage-leaves in the bud is called vernation (*see* Vol. III., p. 213),

being due to branching of a single stamen. Co-radial chorisis is exemplified by the petals in double columbines (*Aquilegia*) and by double daffodils. Both methods may occur together. When, as we have seen, the stamens appear as if coherent in several groups (*polyadelphous*), as in the orange, each group is really a branched stamen, and the "indefinite" stamens of *Malvaceæ* are due to the branching of five original ones.

Cohesion, adhesion, and even chorisis will often not interfere with the polysymmetric character of the flower; but abortion, suppression, and the irregular growth of individual members in a whorl will commonly do so.

Many facts as to floral structure and symmetry can be conveniently represented for comparison in whether the ovary be superior or not in the diagram.

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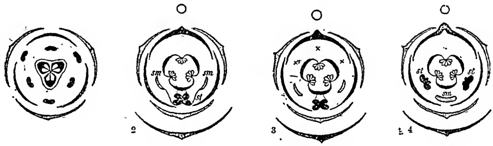

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In colour, such cases as *Fuchsia*, where calyx and corolla are both petaloid, but differently coloured, or the Christmas-rose (*Helleborus niger*), where the sepals are large and petaloid and the petals are small green tubular nectaries, are exceptional.

In duration the sepals may be *caducous*, falling off as the flower opens, as in poppies; *deciduous*, falling with the petals and stamens after fertilisation, as in cherry; or *persistent*, remaining in the fruit stage, as in strawberry and tomato. When persistent, they may be *marcescent*, shrivelling, as in medlar or gooseberry; or *accrescent*, growing larger round the fruit, as in the winter cherry or Cape gooseberry (*Physalis*).

THE COROLLA.

Whilst the outer perianth leaves are, as we have seen, commonly leaf-like, and serve mainly a protective purpose, their frequent hairiness resisting small crawling insects, the *petals* (Greek πέταλον, *pĕtalon*, a leaf), which constitute the *corolla*, are more often delicate in texture, brightly coloured, and odorous, serving the special purpose of attracting flying insects or, in some cases, birds. They are commonly attached by a narrow base, sometimes drawn out into a long narrow portion or *claw* (*unguis*) with a broad expansion, *limb* or *lamina*, above, as in the wallflower, when they are termed *unguiculate*; but the whole petal corresponds in structural origin to the blade of a foliage-leaf. The margin of a petal may be notched, as in chickweed, making the petal *bi-fid*, or fringed (*fimbriate*) as in pinks, or still more cut up (*laciniate*), as in the mignonette or ragged-robin (*Lychnis Flos-cuculi*). In these two last-mentioned genera there are also small scale-like outgrowths, due to chorisis, in front of the base of the lamina, known as *ligules* (Latin *ligula*, a strap); and the tubular outgrowth within the perianth of *Narcissus*, known as the *corona* or *coronet*, is probably of the same nature.

The corolla may be described with reference to (i.) the number of petals; (ii.) union or cohesion; (iii.) insertion or adhesion; (iv.) symmetry and form; (v.) texture; (vi.) colour and markings; (vii.) duration; and (viii.) æstivation. Even in a wild state it is not uncommon for more than one whorl of petals to occur, as in *Magnolia*; but in cultivation this "doubling" is often the result of the transformation of some of the stamens into petals. Otherwise, three among Monocotyledons, and five, or not uncommonly four, among Dicotyledons, are the prevailing numbers of the petals.

If coherent, the petals are *gamopetalous*; if not, *polypetalous*, a discriminating character of great importance in the classification of Dicotyledons. In insertion the corolla is either *hypogynous*, *perigynous*, or *epigynous*, this being also, as we have seen, a point of general importance in classification.

The chief of the many forms of the corolla may be conveniently considered under the two groups of polypetalous and gamopetalous, each group being subdivided into a polysymmetric and a monosymmetric division. Among polysymmetric polypetalous forms the chief are the *rosaceous*, of five petals with short claws or sessile, as in buttercup and in many *Rosaceæ*; the *caryophyllaceous*, of five petals with long claws, as in pinks and other *Caryophyllaceæ*; and the *cruciform*, or cross-shaped, of four petals, with either long or short claws, as in the *Cruciferæ*. The chief monosymmetric polypetalous forms are the *spurred*, as in larkspur (*Delphinium*), where both the posterior sepal and the two posterior petals form spurs, and in *Viola*, where only the posterior petal is spurred; and the *papilionaceous*, characteristic of the pea and bean tribe, which we have already discussed. In gamopetalous corollas we have to consider the *tube* below, the free *limb*, and the *throat* or mouth of the tube, the junction of tube and limb. In the *Boraginaceæ* especially, the throat is commonly more or less closed by five ligule-like scales or by swellings corresponding to pits on the outer surface. The chief polysymmetric gamopetalous forms are the *tubular*, the *campanulate*, the *urceolate*, the *funnel-shaped*, the *salver-shaped*, and the *rotate*. The *tubular*, narrow, and formed by united erect petals, is represented by the disk-florets in many Compositæ, such as the daisy or quilled chrysanthemums, or by all those of thistles, or by the flowers of *Epacris*.

LATIN.—XIX.

(*Continued from Vol. III., p. 377.*)

THE PARTICIPLES.

In Latin there are three participles. The active verb has a present and a future participle.—*e.g.*; amans, *loving*; amaturus, *about to love*; while the passive verb has a past participle—amatus, *loved*. The use of the participles presents few difficulties. Sometimes these are used as attributes, in which case they differ little from adjectives; sometimes they are used as predicates. Examples:—

Alexander *moriens* anulum suum dederat Perdiccae.
Alexander, when dying, had given his ring to Perdiccas.
Amatus est rex bonus.
A good king is loved.

As you will observe from the first example, a participle may take the place of a temporal or relatival clause.

LATIN PROSE.

You have now not only familiarised yourself with the forms of Latin words, but with the rules which

govern the combination of these words into sentences. You will now have some lessons in the writing of Latin Prose. The ability to write prose, such as delighted the contemporaries of Cicero, may not be of any great practical utility; but the achievement is worth striving for, though it is indeed difficult of acquirement, because it affords the student the best possible mental training. Anyone who even vaguely grasps the laws which control the building up of sentences in Latin prose will find it a far easier matter to write modern French or English than he would have done had he been ignorant of the language of Cæsar and Cicero.

§ 1. In order to write Latin prose, it is obviously necessary that the general framework of our sentences—our ways of thought and of expression—should be such as a Latin writer would have used. However desirable it may be that we should also secure beauty of expression and symmetry of form, that our language should be refined and forcible, our phrases picturesque and pointed, yet it cannot be said that failure to attain any of these results is failure to write Latin. If the general structure be correct, then even grammatical mistakes are rather to be looked upon as marks of a bad style—that is, as vulgarisms—than as destructive of the writer's claim to have composed a piece of Latin prose.

To take an illustration from a source outside the sphere of literature and language. There are many different classes of animals, as there are many classes and forms of language. Let us take, as examples, one class of animals, that to which man belongs; and one class of languages, that to which Latin belongs. Now, speaking only from a biological point of view, there are many varieties of men (as has been pointed out already in these pages), differing each one from each other in a great number of particulars. To take only a few of those that strike us most readily—some are tall, strong, and comely, with ample development of muscle and growth of flesh, and healthy condition of skin and complexion and colour; others, on the other hand, are the reverse of all this—stunted, and feeble, and ugly, with meagre casing to their bones, and sickly and sallow in colour of face and skin. And if we take into account their varied clothing and ornaments (that are only adjuncts to their real selves), the differences between them in appearance are of course immeasurably intensified. But all are men. All have something in common by which they are marked off as distinct from all the other animals of the class to which they belong, and with all members of which they share many common characteristics. What is this something? Evidently not the flesh and bones, and hair, and other parts that every animal belonging to the species possesses. It is not any one of these; but it is the particular manner in which all these are put together: that is to say, it is the structure of the whole. And this we see most easily and plainly when all that gave life, and vigour, and beauty, and freshness, and charm to the form of the living man is stripped from off it, and nothing is left but the bare bones of the skeleton. It is by THE SKELETON that we distinguish between man and all other animals of his class, and between each of them in turn.

And the case is just the same with languages, and with particular classes of languages, and, to be brief, with the particular language which we are considering—Latin. It is not any elegant, or sonorous, or vigorous, or rich and warmly-coloured phrases and expressions that make up Latin prose. They cannot make Latin, any more than a particular strength of sinew, or beauty of figure, or colour of skin and flesh and hair, can make a man. They can at most make beautiful, or forcible, or picturesque Latin. There must first be THE LATIN SKELETON—on, to, and round which all these may be moulded and built up. The one indispensable thing is this skeleton; having this, we can write Latin. We have the bare bones: it only remains to clothe them with the choicest expressions which we can find to fit them.

It is thus of the utmost importance to realise as soon as we can the STRUCTURE of the Latin sentence. Not till we have done this can we make any profitable use of our knowledge of Latin words and grammar and especially of elegant or forcible phrases. It will be to this end, therefore, that we shall devote the first portion of this part of our lessons.

§ 2. But before we can really understand the Romans' ways of expression, we must form some clear idea of their ways of thought and feeling. For, of course, the character of a nation must show itself in the language which they have gradually formed for the very purpose of giving expression to their thought. So that if, from what we know of their history and general mode of life (for this will show most plainly what they really were), we can discover any strongly marked characteristics, we may be sure that we shall be quite right in aiming at reproducing those characteristics in our attempt to write their language.

It is evident, then, from all we know of them, that the Roman ideal was not that which the Greeks seem always to have had before them—the Beautiful. On the contrary, they sought, above all, the Useful. The arts, the accomplishments and graces of life, were never the objects of the genuine Roman's aim. He was, above all, practical; going straight to the point with a

vigorous directness of purpose and thoroughness of work, that never swerved aside from any consideration of grace or beauty. In this respect, it is the aqueduct, and the viaduct, and the great roads, built with a solidity that can almost bid defiance to the destructive power of time, and running straight—whatever the obstacles—to their goal, that represent the Roman character, as compared with the temples and statues which are the products of Greek art. To win and work out empire and law, order and government—this was the ideal expressed for Rome by her great epic poet when she had already realised her destiny.

And so it is, above all, this practical aim which we have to keep before us in translating from English into Latin prose.

CLEARNESS, DIRECTNESS, and SIMPLICITY must be our aim. If we can secure at the same time something of the solidity of the aqueduct, so much the better. Most Latin prose has a solid sound about it. But anything vague, roundabout, or involved, anything of a speculative and abstract kind, we must carefully eschew. It is not enough to suggest a thought by implication; we must define and express it. *We must leave nothing to the imagination.* The drama seems never to have really flourished at Rome. The Roman did not care to have suffering or any other feelings represented to him—simply acted before him on the stage. He wanted the real thing itself; he was not content with a picture of it. And so it was the games, the gladiatorial shows, rather than the drama, that gave him what his nature craved.

§ 3. In every instance, accordingly, what we must first endeavour to get hold of is *the precise idea itself*, the very thought or fact, which we have to express. We must free ourselves at once from the intellectual slavery to words which makes us take the English words, one by one, and write down their equivalents in Latin. Often, no doubt, we shall be able to do that, and at the same time write Latin, at all events where the English thought and expression is of a simple kind; but much more often we shall produce by such a process a number of Latin words and constructions individually correct, perhaps, but not a Latin sentence.

Indeed, before we can really write Latin, we have to take our English sentence as a whole, and seize upon the fact or thought which it expresses in its simplest and most precise form, apart from the way in which it is expressed, and then endeavour to put that thought or fact in the way in which a Roman would have expressed it—to clothe it, that is, in its Latin dress. Unless we go to work in this way we have very little chance of ever producing a satisfactory result.

We have thus a good deal to do before we can begin our translation. Indeed, the chief difficulty is often just this process of finding out what is, in its simplest and most concrete form, the idea which the English is meant to express. In the reverse process—which we have then to go through—of reclothing the idea in a Latin dress, we have to depend for the most part on our reading and memory and our knowledge of Latin ways of thought and expression. But the earlier process it is that tests most searchingly our logical power and intelligence—our grasp of thought as opposed to our command of words; and it is this, therefore, it seems, that is the most valuable part of the intellectual training afforded by practice in composition in Latin.

§ 4. Of course, all that has been said of translation from English into Latin applies to *the translation of Latin into English;* and nothing will help us more to translate a piece of English into real Latin than the determination, whenever we are translating Latin into English, not to rest until—instead of Latin ways of thought and expression in English words—we have succeeded in getting throughout not only the English words, but also the English ways of thought and the idiomatic English ways of expression.

Let us take a dozen lines of a Latin prose author, and translate them as literally as possible into English (if for the moment we may call it so); and then let us take our translation and con it over until we have got all the thoughts and facts expressed by it well in our mind, and then let us put it away, and proceed to write it all out in our own language as a piece of original English of our own composition. We shall then have a piece of "natural" English, showing the ways of thought and expression that are natural to our language. And if after this we carefully compare together our two pieces of English, we shall give ourselves one of the most effective lessons that we could have in the differences of structure between the two languages, English and Latin, which is just what we have seen to be the most essential thing for us to feel and know.

The following few lines of Livy contain in a short space many characteristic differences, and will supply the means for an immediate self-given lesson of the kind suggested, and also serve for future reference:—

"Fama est etiam, Hannibalem annorum ferme novem, pueriliter blandientem patri Hamilcari, ut duceretur in Hispaniam, quum perfecto Africo bello exercitum eo trajecturus sacrificaret, altaribus admotum, tactis sacris, jure jurando adactum, se, quum primum posset, hostem fore

populo Romano.. Angebant ingentis spiritus virum Sicilia Sardiniaque amissae: nam et* Siciliam nimis celeri desperatione rerum concessam et Sardiniam inter motum Africae fraude Romanorum, stipendio etiam insuper imposito, interceptam."—*Livy*, xxi. 1 *ad fin.*

§ 5. Another conspicuous characteristic of the Romans, which we must always be looking for opportunities of reproducing in our Latin prose, is their RHETORICAL tendency: a tendency, however, which in combination with their other characteristics already alluded to (especially the desire for directness of expression) appears chiefly in devices of one kind or another for securing emphasis. It was not till their literature—the mirror of their life—was degenerating and decaying, that this tendency assumed the form of a straining after superficial effect and showy modes of expression, at the sacrifice of truth and proportion, revealing the loss in their minds of the sense of proportion for which the writers of the best periods are conspicuous. During these earlier periods, their strong common sense and intolerance of anything illogical or fantastic and imaginative, tended to keep the rhetorical instinct within sober bounds. Logic and rhetoric, which in modern times have come to be regarded almost as irreconcilable, were then united in a firm alliance. The result of the fusion of the two was an orderly directness and clearness of thought, combined with a restrained earnestness and emphasis of expression, which at once dispenses with all words that are not necessary to the meaning, and employs the utmost care in choosing such as will be most effective, and in arranging them in the most effective order.

Indeed, it is by the order in which the words are arranged that Latin produces its most emphatic and varied effects, and attains most readily its clearness, alike in the simple and in the compound sentence. We shall have to notice very carefully Latin usage in this matter.

But in order to consider this with profit, we must have got a clear conception of the different kinds of sentence used in Latin—that is, of the structure of the language. To this, then, we must turn our attention.

§ 6. But before we pass on, it will be well to take a few simple examples to illustrate some of these general characteristics of Latin which we have mentioned, and which we must keep before us in every attempt to translate one language into the other.

* *Nam et . . . concessam et . . . interceptam* [esse] is the accusative and infinitive construction giving the reason for the idea expressed in *angebant*, and grammatically dependent on that idea rather than on the actual expression (= "for he thought that . . .").

We may sum up some of what has been said of them in these three maxims:—

1. First get down to the exact fact.
2. When you have got it, express it (1) as simply and precisely, (2) as strongly and vividly as possible.
3. Choose, therefore, concrete and personal, rather than abstract and impersonal, ways of expression.

N.B.—The greater general exactitude of Latin compared with English will be constantly visible, especially in the use of tenses and pronouns.

§ 7. In any language a *sentence* is such a combination of words as makes a statement about something or somebody, asks a question, or expresses a command, request, prayer, or wish.

All sentences are thus either (1) statements, or (2) questions, or (3) "petitions."

And every sentence consists essentially of two parts—subject and predicate: of which the *subject* (which in inflectional languages is often expressed only by the personal termination of the verb) is that of which something is stated, or asked, or requested; and the *predicate* is that which is stated, or asked, or requested in relation to the subject: *e.g.*—

(1) Cicero was an orator.
Cicero orator fuit.

Here we have the simplest form of predication, Cicero being the subject, and the rest of the sentence the predicate, and the verb being merely a link between the two ideas *Cicero* and *orator*.

Brutus killed Cæsar.
Brutus Caesarem occidit.

Here Brutus is the subject, and the rest is the predicate, but the verb adds a new idea.

(2) Where have you come from?
Unde advenisti?

Here *you* (expressed in Latin by the personal termination of the verb) is the subject, and the rest is the predicate.

(3) Depart (let him depart, may he depart) from Italy.
Discede (discedat) ab Italia.

Here the subject is in English *thou* (understood) or *he*, and in Latin is expressed by the personal termination, and the rest is the predicate.

§ 8. A *simple sentence* is one which consists of a single subject and a single predicate. Sometimes we have *either* two or more subjects connected by a conjunction with a single predicate, *or* two or more predicates similarly connected with a single subject. These may, perhaps, be regarded as simple sentences with *practically* one subject and one predicate—*e.g.*, "He and I did this," where *He*

and. I expresses practically one idea, viz., *we;* and "You shoot and kill and eat my birds," where we have the one subject *you* and the three verbs run together into one whole thought. [Otherwise, they must be regarded as equivalent to two sentences co-ordinated by "and": *e.g.*, "He did this, *and* I did this" (*vide infra*, § 9).]

In any such simple sentence, the subject may have attached to it adjectival or pronominal epithets, or words in apposition fulfilling the same function; and the predicate, in like manner, may be expanded and defined by the addition to the verb of nouns expressing the different objects or spheres of its action (variously qualified just as the subject may be), and of adverbs and adverbial phrases of many kinds further explaining the circumstances under which the action takes place.

Thus, the first two sentences given in § 7 as examples of a simple statement might while still remaining simple sentences be expanded as follows:—

(*a*) Magnus ille Cicero, multorum de philosophia librorum ac sermonum—ingeni sui eximii documento posteris mansurorum—summa cum laude scriptor, per odium ex eloquentia illa exortum jam senex interfectus, omnes inter oratores in omne tempus clarissimus exstabit.

(*b*) Ipse Brutus amicus, omnium illius erga se beneficiorum oblitus, Caesarem jam summos honores a populo Romano adeptum pugione consulto ad id parato libertatis causa inprudentem invitus percussit.

If we had to express these sentences in idiomatic English, we should have to substitute subordinate clauses, connected with the main clause by a conjunction or a relative, for some of the adjectival and adverbial phrases which Latin can freely use. And in doing this we should change the sentences from simple into *compound* sentences. (It will be useful to the student to repeat with these examples the process recommended in § 4 *supra*.)

TRANSLATION FROM PLINY.

The next piece chosen for translation is from one of the letters of Pliny. Pliny (born about 62 A.D.) was a Roman statesman, who led an active life, but found time to write many excellent letters. A large number of these have been preserved, and not only give us, as has been said, "the fullest and fairest portrait we possess of a Roman gentleman," but the best picture of life in Italy under the Empire. The passage below, however, does not deal with history or politics, but relates the story of a haunted house at Athens. It is very similar to many ghost stories with which we are familiar, and we can only regret that Pliny was not the president of a Roman Society for Psychical Research, in which case he would have doubtless preserved for us many more narratives of equal interest. In this letter Pliny is discussing with a friend whether ghosts really exist or not, and, after giving another instance, he relates the following.—

Erat Athenis spatiosa et capax domus, sed infamis et pestilens. Per silentium noctis sonus ferri. et, si attenderes acrius, strepitus vinculorum longius primo, deinde e proximo reddebatur: mox apparebat idolon, senex macie et squalore confectus, promissa barba, horrenti capillo: cruribus compedes, manibus catenas gerebat quatiebatque. Inde inhabitantibus tristes diraeque noctes per metum vigilabantur: vigiliam morbus et crescente formidine mors sequebatur. Nam interdiu quoque, quamquam abscesserat imago, memoria imaginis oculis inerrabat, longiorque causa timoris timor erat. Deserta inde et damnata solitudine domus, totaque illi monstro relicta; proscribebatur tamen, seu quis emere, seu quis conducere, ignarus tanti mali, vellet. Venit Athenas philosophus Athenodorus, legit titulum: auditoque pretio, quia suspecta vilitas, percunctatus, omnia docetur, ac nihilo minus, immo tanto magis conducit.

NOTES.

Athenis. This case is used to denote place. It is in form like the ablative, but is supposed to be really an old locative case.

Pestilens. "Deadly, fatal." As he tells us, it had caused the death of many.

Attenderes. The second person singular is often used to denote an indefinite subject. Here it = "if one listened more carefully."

Longius primo. "First at some distance." The comparative of adjectives and adverbs is often used to denote that the quality exists in a moderate degree.

E proximo. Lit., "*from* a near spot," *i.e.* "near at hand."

Idolon. A word the Latins took from the Greek, means an image; here it is used to describe the ghost, as the Latin word *imago* is used below.

Inhabitantibus. "Those dwelling in the house," is a dative, and must be taken with *vigilabantur.*

Vigilabantur. *Vigilare* = "to be awake, to watch," and with an accusative "to pass in watching, to pass sleeplessly." Trans., "Sleepless nights were passed."

Per metum. "Owing to (their) fear."

Vigiliam morbus sequebatur. "Illness followed the sleeplessness;" we should express an idea like this passively, "sleeplessness was followed by illness."

Imago. "The apparition."

Longiorque, etc. This sentence is rather difficult. The order is *longior timor causa timoris erat*, "their fear being prolonged (lit., longer) was the cause of (fresh) fear," *i.e.*, their imaginations increased their alarm.

Deserta, supply *est;* the auxiliary verb *sum* is often omitted, cf. *suspecta* below.

Damnata solitudine. "Condemned *to* solitude." *Damno*, to condemn, takes a dative or ablative of the punishment.

Tota. "Wholly": adjective used as adverb.

Proscribebatur. "Advertised." As in England, houses to let had a bill (*titulus*) put on them, and people wishing to hire had to go to the agent to inquire the price (cf. *audito pretio* below).

populo Romano.. Angebant ingentis spiritus virum Sicilia Sardiniaque amissae: nam et* Siciliam nimis celeri desperatione rerum concessam et Sardiniam inter motum Africae fraude Romanorum, stipendio etiam insuper imposito, interceptam."—*Livy*, xxi. 1 *ad fin.*

§ 5. Another conspicuous characteristic of the Romans, which we must always be looking for opportunities of reproducing in our Latin prose, is their RHETORICAL tendency: a tendency, however, which in combination with their other characteristics already alluded to (especially the desire for directness of expression) appears chiefly in devices of one kind or another for securing emphasis. It was not till their literature—the mirror of their life—was degenerating and decaying, that this tendency assumed the form of a straining after superficial effect and showy modes of expression, at the sacrifice of truth and proportion, revealing the loss in their minds of the sense of proportion for which the writers of the best periods are conspicuous. During these earlier periods, their strong common sense and intolerance of anything illogical or fantastic and imaginative, tended to keep the rhetorical instinct within sober bounds. Logic and rhetoric, which in modern times have come to be regarded almost as irreconcilable, were then united in a firm alliance. The result of the fusion of the two was an orderly directness and clearness of thought, combined with a restrained earnestness and emphasis of expression, which at once dispenses with all words that are not necessary to the meaning, and employs the utmost care in choosing such as will be most effective, and in arranging them in the most effective order.

Indeed, it is by the order in which the words are arranged that Latin produces its most emphatic and varied effects, and attains most readily its clearness, alike in the simple and in the compound sentence. We shall have to notice very carefully Latin usage in this matter.

But in order to consider this with profit, we must have got a clear conception of the different kinds of sentence used in Latin—that is, of the structure of the language. To this, then, we must turn our attention.

§ 6. But before we pass on, it will be well to take a few simple examples to illustrate some of these general characteristics of Latin which we have mentioned, and which we must keep before us in every attempt to translate one language into the other.

* *Nam et . . . concessam et . . . interceptam* [*esse*] is the accusative and infinitive construction giving the reason for the idea expressed in *angebant*, and grammatically dependent on that idea rather than on the actual expression (= "for he thought that . . .").

We may sum up some of what has been said of them in these three maxims:—

1. First get down to the exact fact.
2. When you have got it, express it (1) as simply and precisely, (2) as strongly and vividly as possible.
3. Choose, therefore, concrete and personal, rather than abstract and impersonal, ways of expression.

N.B.—The greater general exactitude of Latin compared with English will be constantly visible, especially in the use of tenses and pronouns.

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effect on the higher animals, but is poisonous to flies.

ROHUN BARK (*Soymida febrifuga*).—A large tree of Central and Southern India, belonging to the natural order Meliaceæ. The bark is used in India as an astringent tonic and antiperiodic, in intermittent fevers, general debility, diarrhœa, and in the advanced stages of dysentery. It was sent by Roxburgh to Edinburgh at the end of the last century, for trial, and was introduced into the Edinburgh Pharmacopœia in 1803, and into the Dublin Pharmacopœia in 1807.

COWHAGE OR COW-ITCH (*Mucuna pruriens*).—A strong climbing, leguminous plant, common throughout the tropics of India, Africa, and America. It produces a large number of pods from 2 to 4 inches long and about half an inch wide. They are slightly curved, of a dark brownish colour, and thickly covered with stiff sharp hairs, which are easily detached from the valves, and penetrate the skin, causing an intolerable itching. These hairs have long been known as a vermifuge; and in this country began to attract attention at the latter part of the last century. As a drug, cowhage was introduced into the Edinburgh Pharmacopœia in 1783 and into the London Pharmacopœia in 1809. It is now seldom used in European practice.

WILD BLACK CHERRY BARK (*Prunus serotina*).—A plant of variable habit, widely spread over North America, forming a shrub in some localities, and in more favourable situations growing to a height of 60 feet. It belongs to the natural order Rosaceæ. The bark has a high reputation in America as a mild tonic and sedative, and was introduced to notice in this country in 1863, but is not much used with us in medical practice.

CHERRY LAUREL LEAVES (*Prunus Lauro-cerasus*).—This well known evergreen shrub thrives well with us, and in other countries where the winters are not severe. It is a native of the Caucasus provinces of Russia, North-western Asia Minor, and Northern Persia, and has been introduced on account of its ornamental appearance to all the more temperate parts of Europe. The leaves, cut up and distilled with water, yield an oil similar to that of bitter almonds and containing hydrocyanic acid. They are used for making cherry-laurel water, and were introduced to the British Pharmacopœia in 1839.

CAJUPUT OIL (*Melaleuca Leucadendron*, var. *minor*).—This is a large myrtaceous tree, abundant and widely spread in the Indian Archipelago and Malay Peninsula. The oil, which is obtained from the leaves by distillation, is chiefly prepared in the island of Bouro, one of the Moluccas. It first made its appearance at Amsterdam about 1727, was admitted to the Edinburgh Pharmacopœia in 1788, but does not appear to have become an article of commerce with us until 1813. It is used externally as a rubefacient, and occasionally given internally as a stimulant and diaphoretic.

GAMBIER OR TERRA JAPONICA (*Uncaria Gambier*).—The plant yielding this substance is a strong-growing climber, belonging to the natural order Rubiaceæ, and native of the countries bordering the Straits of Malacca. It is also grown in Ceylon. For commercial purposes plantations were formed for its cultivation in Singapore so far back as 1819, and at the present time is grown there on a very large scale. Gambier is prepared by boiling the leaves and young shoots in water in an iron pan, after which the decoction is evaporated to the consistence of a thin syrup, when it is poured into buckets and submitted to a kind of churning action, when it becomes thick and sets into a mass resembling a soft yellowish clay, which is put into square boxes and cut into cubes, and dried, when it is ready for exportation. It was first brought to notice in this country about the year 1807, and is used medicinally as an astringent. It is also largely used in dyeing and tanning. In consequence of the great demand for this substance, plants were sent from Kew for trial in the West Indies in 1890 (*Kew Bulletin*, 1891, p. 106). The plant has also been introduced and cultivated in British North Borneo, and the Gambier produced there reported favourably upon in the London market (*Kew Bulletin*, 1893, p. 139).

INDIAN TOBACCO (*Lobelia inflata*).—An erect annual or biennial herb, 9 to 18 inches high, widely distributed over the Northern United States, belonging to the natural order Campanulaceæ. The dried herb is imported into this country in pieces of varying sizes, and compressed into oblong packages.

CHIRETTA (*Swertia chirata*).—An annual herb belonging to the natural order Gentianeæ, and native of the mountainous regions of Northern India. The whole plant possesses a strong bitter taste, and has long been held in high repute by the Hindoos as a tonic. About 1829 it began to attract some attention in England, and was admitted to the Edinburgh Pharmacopœia in 1839. It is a pure bitter tonic, without aroma or astringency, and is used in this country chiefly in the form of tincture. It is also said to be used, in the place of gentian, to give flavour to the compound cattle foods now so general.

BELLADONNA OR DEADLY NIGHTSHADE (*Atropa Belladonna*).—This well known herbaceous plant is very widely spread, not only in this country but also through Central and Southern Europe, Caucasia, and Northern Asia Minor. The roots are chiefly used for the preparation of atropine, employed in

ophthalmia for dilating the pupil of the eye, and for making a liniment for neuralgic pains; for this purpose it was introduced about 1860. The leaves were introduced into the London Pharmacopœia in 1809, for the preparation of extracts and tincture.

BEBEERU OR GREENHEART BARK (*Nectandra Rodiæi*).—A large hard-wooded forest tree of British Guiana. The thick bark contains an alkaloid known as *Beberine*, and has been recommended as a bitter tonic and febrifuge; it first attracted attention about 1835, and the alkaloid was further examined in 1843. The supply of Greenheart bark to the English market is very irregular.

MATICO (*Piper angustifolium*).—This is a shrub belonging to the natural order Piperaceæ, native of Bolivia, Peru, Brazil, Venezuela, and New Granada. Matico, as seen in commerce, consists of the broken and compressed leaves, which are very thick and very rough on the surface; they have a pleasant, somewhat pungent odour, and a bitterish aromatic taste. They are used either softened in water, or reduced to a powder, to stop bleeding, and an infusion prepared from them is also administered for internal hæmorrhage. They come by way of Panama in bales or serons.

Matico was first brought to notice in this country by a Liverpool physician in 1839.

Though the source of Matico is generally believed to be the plant mentioned above, the leaves of other allied species no doubt are often mixed with them. Thus, at the close of the year 1888, a consignment of Matico leaves reached the London market, which proved to be derived from *Piper Mandoni*.

LARCH BARK (*Larix europea*).—The bark of this well-known tree, which has been known for a very long time to possess astringent properties, and is in consequence used for tanning, was first brought to notice in this country in 1858, as a stimulating astringent and expectorant. It is used chiefly in the form of a tincture.

ARECA OR BETEL NUTS (*Areca Catechu*).—This is a palm growing to a height of 40 or 50 feet, with a straight smooth trunk from one to two feet in circumference. The tree is probably a native of the Malayan Archipelago, where it is also cultivated as well as in the warmer parts of the Indian Peninsula, Ceylon, and the Philippine Islands. The seeds of this palm, which are known as Areca nuts, are about the size and appearance of a small nutmeg, somewhat flattened at the base, and like the nutmeg, they are ruminated or marked throughout their substance by dark irregular lines. They possess astringent properties, and are held in high repute among Asiatics as a masticatory as well as for strengthening the gums and sweetening the breath. It has attracted some attention of late years as a tænifuge for the expulsion of tapeworm, given in doses of from four to six drachms in milk, and has been used in this country more or less for this purpose since 1867.

INDIAN POKE-ROOT (*Veratrum viride*).—A plant belonging to the natural order Liliaceæ, and common in swamps and low grounds from Canada to Georgia. The purgative and antiscorbutic properties of the plant have long been known in North America, and in 1862 the roots, or more properly the rhizomes, were introduced into this country as a cardiac, arterial, and nervous sedative.

COLCHICUM SEEDS (*Colchicum autumnale*).—A well-known liliaceous plant in meadows and pastures in this country, as well as over a large portion of Middle and Southern Europe. The corms are the source of the specific known as wine of Colchicum, and have been used in medicine from early times.

In 1820 the seeds were introduced into medical practice on account of their being said to have a more certain action than the corm, and were introduced into the Pharmacopœia in 1821.

NEW DRUGS.

To give a complete list of the new remedies that have been brought to the notice of the British pharmacist during comparatively recent years would occupy much more space than would be justifiable, for scarcely a week now passes without the appearance of a note on some novelty in the pages of the Medical and Pharmaceutical journals. It will therefore suffice to enumerate only those to which most attention has been given, such as those which have already come into use, or which promise to become established medicines. Those which are enumerated below are classified in alphabetical order of their scientific nomenclature.

Abrus precatorius.—A common tropical plant belonging to the natural order Leguminosæ, well known for its small globose scarlet and black seeds, which are used almost everywhere in the tropics for making necklaces, bracelets, and other ornaments, as well as for weights by the diamond merchants in India. These seeds began to attract attention in 1882, having been experimented with on the Continent in the treatment of ophthalmic diseases under the name of JEQUIRITY. In Egypt they are occasionally used as an article of food and are harmless, but powdered and introduced beneath the skin they rapidly produce fatal effects. The poisonous action is due to the presence of *abrine*, which is rendered inert by heat, and is closely allied to albumin in composition. It is

obtainable also from the roots and stem of the plant. This plant has recently become known as the weather plant.

Alstonia scholaris.—A tree 50 to 80 feet high, widely diffused in India, Africa, and Australia, and belonging to the natural order Apocynaceæ. The bark is powerfully bitter, and is used by the natives of India in bowel complaints. Under the name of DITA bark, it began to attract attention in this country in 1875 as a most valuable antiperiodic and tonic.

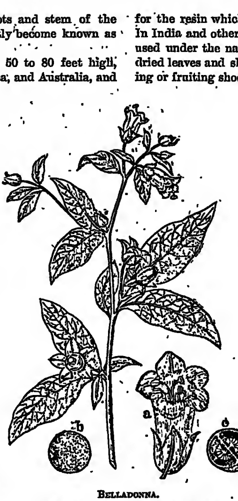
An allied species, *A. constricta*, a native of Queensland and New South Wales, and known as the QUEENSLAND FEVER BARK, where it has had a reputation for some time, has also been introduced since 1878, and used as a tonic and febrifuge.

Andira araroba.—Under the name of GOA POWDER, a substance was introduced in 1874 to the notice of pharmacists as a cure for ringworm and other skin diseases. The drug was imported into the London and Liverpool markets from Bahia, and consisted of lumps of a yellowish substance, composed partly of powder and partly of pieces of wood. For some time its botanical source remained unknown; specimens of the plant were, however, afterwards received, which led to its determination as above.

The active principle of the drug, called Chrysophanic acid, soon obtained for it a reputation in the cure of the diseases referred to, and the drug is still included in the chemist's trade lists.

Aspidosperma Quebracho-blanco.—A tree, native of the Argentine Republic, and belonging, like the last, to the natural order Apocynaceæ, furnishes the Quebracho-blanco or White Quebracho bark of commerce. It is used in various forms of dyspepsia, bronchitis, phthisis, etc., and was introduced to the notice of English pharmacists in 1879.

Cannabis indica.—The common HEMP is well known to be valuable for two distinct economic uses, namely, when grown in cool countries it is valued for its fibre, and when grown in hot countries, for the resin which is secreted all over the plant. In India and other tropical countries, this is much used under the names of Bhang, consisting of the dried leaves and slender stalks; Ganja, the flowering or fruiting shoots; and Churrus, the resin itself. The introduction of the Indian drug into European practice is chiefly due to experiments made in Calcutta by Dr. O'Shaughnessy, in 1838–39.



BELLADONNA.
a, Flower; b, Fruit; c, Section of Fruit.

Carica papaya. — The PAPAW tree has always had a peculiar interest attached to it, in consequence of the statements of travellers that it possessed the extraordinary property of rendering tough flesh tender by merely hanging the freshly killed meat amongst the foliage of the tree. In the "Natural History of Jamaica," Browne says that meat is quickly made tender by washing it with water mixed with Papaw juice, and if left in the water for ten minutes, the meat will fall to pieces or divide into shreds during the process of cooking. Nothing like real attention was given to this important property till about 1878, since which time it has received considerable notice at the hands of chemists and the medical profession, not only in this country but in Europe generally, in the treatment of dyspepsia, diphtheria, etc. The native country of the plant is supposed to be the warm part of the American continent, but it is now widely scattered in tropical countries in both hemispheres. The fresh fruits are generally cooked and eaten as a green vegetable in the countries where the plant grows.

Cinnamodendron corticosum.—Under the name of RED CANELLA, MOUNTAIN CINNAMON, or FALSE WINTER'S BARK, the bark of this tree has been long known for its stimulant, tonic, aromatic, and anti-scorbutic properties. It is a small tree, 10 to 15 feet high, but sometimes growing to a height of 90 feet. It is confined to Jamaica; and though the bark has been well known for so long, the plant remained undescribed till about 27 years ago. Plants have been in cultivation in the Royal Gardens, Kew, and in the Gardens of the Royal Botanical Society,

ophthalmia for dilating the pupil of the eye, and for making a liniment for neuralgic pains; for this purpose it was introduced about 1860. The leaves were introduced into the London Pharmacopœia in 1809, for the preparation of extracts and tincture.

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In 1820 the seeds were introduced into medical practice on account of their being said to have a more certain action than the corm, and were introduced into the Pharmacopæia in 1824.

NEW DRUGS.

To give a complete list of the new remedies that have been brought to the notice of the British pharmacist during comparatively recent years would occupy much more space than would be justifiable, for scarcely a week now passes without the appearance of a note on some novelty in the pages of the Medical and Pharmaceutical journals. It will therefore suffice to enumerate only those to which most attention has been given, such as those which have already come into use, or which promise to become established medicines. Those which are enumerated below are classified in alphabetical order of their scientific nomenclature.

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volatile oil. They have been recommended as a remedy in fevers. The oil distilled from them is tonic, stimulant, and antiseptic. It has been used externally as a rubefacient, also in perfumery for scenting soaps, and internally in bronchial and diphtheritic affections under the name of *Eucalyptol*. The resin of this species and that of *Eucalyptus amygdalina* forms Australian Kino.

Euphorbia Drummondii.—A prostrate or diffused much-branched plant of Australia. An alkaloid contained in this plant called *Drumine* has been discovered and applied within the past year as a local anæsthetic.

FRENCH.—XIX.

[Continued from Vol. III., p. 353.]

FORMATION OF THE FEMININE OF NOUNS.

NOUNS referring to persons and animals generally alter their termination in the feminine.

Many nouns form their feminine by adding *e* mute to the masculine, whether the latter ends with a consonant or a vowel :—

Masculine.	*Feminine.*
Voisin, *neighbour.*	Voisine.
Ours, *bear.*	Ourse.
Marquis, *marquis.*	Marquise.
Ami, *friend.*	Amie.
Mahométan, *Mahometan.*	Mahométane.
Marchand, *merchant.*	Marchande.

This is the most general method of forming the feminine.

The following form their feminine by adding *-esse*, with or without a modification of the masculine ending :—

Masculine.	*Feminine.*
Dieu, *a god.*	Déesse.
Devin, *a soothsayer.*	Devineresse.
Larron, *a thief.*	Larronnesse.
Pair, *a peer.*	Pairesse.
Duc, *a duke.*	Duchesse.

Nouns ending in *-teur* (not derived from present participles) form their feminine by changing *-eur* into *-rice* :—

Masculine.	*Feminine.*
Accusateur, *accuser.*	Accusatrice.
Ambassadeur, *ambassador.*	Ambassadrice.
Bienfaiteur, *benefactor.*	Bienfaitrice.
Acteur, *actor.*	Actrice.
Débiteur, *debtor.*	Débitrice.
Tuteur, *guardian.*	Tutrice.
Conducteur, *conductor.*	Conductrice.

Nouns ending in *-eur*, derived from present participles, form their feminine by changing *-r* into *-se* :—

Present Participle.	*Masculine.*	*Feminine.*
Chantant,	Chanteur, *singer.*	Chanteuse.
Chassant,	Chasseur, *hunter.*	Chasseuse.
Polissant,	Polisseur, *polisher.*	Polisseuse.
Débitant,	Débiteur, *newsmonger.*	Débiteuse.
Demandant,	Demandeur, *applicant.*	Demandeuse.
Vendant,	Vendeur, *seller.*	Vendeuse.
Devinant,	Devineur, *one who guesses.*	Devineuse.

When *demandeur* has the legal signification of *plaintiff*, its feminine is *demanderesse*.

Nouns ending in *x* form their feminine by changing *x* into *s* and adding *e* : those ending in *f* change it into *v* and add *e* :—

Masculine.	*Feminine.*
Époux, *husband.*	Épouse.
Veuf, *widower.*	Veuve.
Chartreux, *Carthusian.*	Chartreuse.
Gueux, *beggar, vagabond.*	Gueuse.

Nouns ending in *-en*, *-et*, *-on*, *-ot*, double the last consonant, and add *e* :—

Masculine.	*Feminine.*
Parisien, *Parisian.*	Parisienne.
Chien, *dog.*	Chienne.
Sujet, *subject.*	Sujette.
Vigneron, *vine-dresser.*	Vigneronne.
Lion, *lion.*	Lionne.
Sot, *fool.*	Sotte.

In the same way *paysan* and *chat* form their feminine. Thus :—

Masculine.	*Feminine.*
Paysan, *peasant.*	Paysanne.
Chat, *cat.*	Chatte.

Others form their feminine by adding to the masculine either *e* mute or a syllable ending in *e* mute (such as *-ine*, *-ide*, etc.), with or without the dropping of the whole or a part of the masculine termination :—

Masculine.	*Feminine.*
Czar, *Czar.*	Czarine.
Héros, *hero.*	Héroïne.
Sylphe, *sylph.*	Sylphide.
Nègre, *negro.*	Négresse.
Compagnon, *companion.*	Compagne.
Vieillard, *old man.*	Vieille.
Cochon, *pig.*	Coche.
Canard, *drake.*	Cane.
Poulain, *colt.*	Pouliche.
Taureau, *bull.*	Taure.
Mulet, *mule.*	Mule.
Loup, *wolf.*	Louve.

Many have different forms for the masculine and the feminine :—

Masculine.	*Feminine.*
Père, *father.*	Mère.
Frère, *brother.*	Sœur.
Oncle, *uncle.*	Tante.
Gouverneur, *governor.*	Gouvernante.
Cheval, *horse.*	Jument.
Empereur, *emperor.*	Impératrice.
Roi, *king.*	Reine.
Serviteur, *servant.*	Servante.
Bélier, *ram.*	Brebis.
Sanglier, *wild boar.*	Laie.

You will notice that here the French and English usage is the same. And that many of the words which in French have different forms for the masculine and feminine, have also different forms in English.

Nouns expressing professions and trades generally carried on by men have no feminine :—

Graveur, *engraver.*	Peintre, *painter.*	Médecin, *physician.*
Sculpteur, *sculptor.*	Écrivain, *writer.*	Poète, *poet.*
Imprimeur, *printer.*	Docteur, *doctor.*	Auteur, *author,* etc.

Témoin, *witness;* adversaire, *adversary;* imposteur, *impostor;* artisan, *artisan;* and partisan, *partisan,* have no feminine.

When the nouns mentioned in the last two lists are used in reference to females, the words depending upon them remain in the masculine:—

Cette dame est un bon peintre, un poète *fameux*, un écrivain connu. Cette femme est un imposteur, un *faux* témoin. La princesse était pour lui un adversaire *généreux*.

Some nouns referring to animals have only one gender, either masculine or feminine:—

Masculine.	*Feminine.*
Castor, *beaver.*	Girafe, *giraffe.*
Écureuil, *squirrel.*	Panthère, *panther.*
Éléphant, *elephant.*	Hyène, *hyena.*
Crocodile, *crocodile.*	Souris, *mouse.*
Vautour, *vulture,* etc.	Perdrix, *partridge,* etc.

To such nouns the words *mâle* or *femelle* is added when it is necessary to mention the gender: *un éléphant femelle; une girafe mâle.*

Exceptions to the Rules given above.

Many nouns ending in *e* do not change in the feminine:—

Masculine.	*Feminine.*
Un Russe, *a Russian.*	Une Russe.
Un artiste, *an artist.*	Une artiste.
Un camarade, *a comrade.*	Une camarade.
Un élève, *a pupil.*	Une élève.
Un compatriote, *a compatriot.*	Une compatriote.
Un esclave, *a slave.*	Une esclave.
Un pupille, *a ward.*	Une pupille.
Un pensionnaire, *a boarder.*	Une pensionnaire.
Un malade, *a sick man.*	Une malade.
Un locataire, *a tenant.*	Une locataire.

The following, however, which end in *é* or in *e*, add *-sse* in the feminine:—

Masculine.	*Feminine.*
Abbé, *abbot.*	Abbesse.
Âne, *ass.*	Ânesse.
Chanoine, *canon.*	Chanoinesse.
Comte, *earl, count.*	Comtesse.
Druide, *druid.*	Druidesse.
Hôte, *host, guest.*	Hôtesse.
Maître, *master.*	Maîtresse.
Nègre, *negro.*	Négresse.
Prêtre, *priest.*	Prêtresse.
Prince, *prince.*	Princesse.
Prophète, *prophet.*	Prophétesse.
Suisse, *a Swiss.*	Suissesse.
Tigre, *tiger.*	Tigresse.
Traître, *traitor.*	Traîtresse.

And poète, *poet*, which has a feminine, *poétesse*, that is rarely used.

The following, although derived from present participles, form their feminine by changing *-eur* into *-rice* and *-eresse:*—

Masculine.	*Feminine.*
Exécuteur, *executor.*	Exécutrice.
Inspecteur, *inspector.*	Inspectrice.
Inventeur, *inventor.*	Inventrice.
Persécuteur, *persecutor.*	Persécutrice.
Enchanteur, *enchanter.*	Enchanteresse.
Pécheur, *sinner.*	Pécheresse.
Vengeur, *avenger.*	Vengeresse.

N.B.—The three following are law terms:—

Bailleur, *lessor.*	Bailleresse.
Défendeur, *defendant.*	Défenderesse.
Vendeur, *vendor.*	Venderesse.

Chasseur, *hunter*, has another feminine, *chasseresse*, which is only used in poetry; and chanteur, *singer*, has also a second feminine, *cantatrice*, which is applied to eminent professional singers.

The feminine of bailli, *bailiff*, which was formerly spelt baillif, is accordingly baillive.

The nouns bigot, *bigot;* cagot, *hypocrite;* dévot, *devotee;* idiot, *idiot*, form their feminine regularly —*i.e.*, by adding *e:* Bigote, cagote, dévote, idiote.

Formation of the Plural of Nouns.

The plural in French, as in English, is formed by the addition of *s* to the singular:—

Singular.	*Plural.*
maison, *house.*	maisons, *houses.*
ville, *town.*	villes, *towns.*

This is the general rule, to which there are the following exceptions:—

First Exception.—Nouns ending in the singular with *s*, *x*, or *z*, do not change in the plural:—

Singular.	*Plural.*
fils, *son.*	fils, *sons.*
voix, *voice.*	voix, *voices.*
nez, *nose.*	nez, *noses.*

Second Exception.—Nouns ending in the singular with *-au*, *-eau*, *-eu*, and *-œu*, take *x* in the plural:—

Singular.	*Plural.*
boyau, *bowel.*	boyaux, *bowels.*
chapeau, *hat.*	chapeaux, *hats.*
feu, *fire.*	feux, *fires.*
vœu, *vow.*	vœux, *vows.*

However, landau, *landau*, forms its plural by adding *s:* landaus.

Third Exception.—Nouns ending in *-ou* form their plural by adding *s*, except the following, which take *x* in the plural:—

Singular.	*Plural.*
bijou, *jewel.*	bijoux, *jewels.*
caillou, *pebble.*	cailloux, *pebbles.*
chou, *cabbage.*	choux, *cabbages.*
genou, *knee.*	genoux, *knees.*
hibou, *owl.*	hiboux, *owls.*
joujou, *plaything.*	joujoux, *playthings.*
pou, *louse.*	poux, *lice.*

It is impossible to explain these two last exceptions on any other ground than that of custom. In early times the spelling of French words was not governed by invariable rules. Instead of *s* mute, *z* or *x* was frequently written, and as French orthography became more precise, *x* was retained in the plural of some nouns, *s* in the plural of others. The consequence of this has been the confusion which exists to-day. It is important to remember

that there is no reason in the nature of things that the plural of *bijou* should be *bijoux*, while the plural of *clou* is *clous*. It is only a matter of custom.

Fourth Exception.—The following nouns ending in *-ail*, change that termination into *-aux* in the plural: *—

Singular.	*Plural.*
bail, *lease.*	baux, *leases.*
corail, *coral.*	coraux, *corals.*
émail, *enamel.*	émaux, *enamels.*
soupirail, *air-hole.*	soupiraux, *air-holes.*
sous-bail, *under-lease.*	sous-baux, *under-leases.*
travail, *labour.*	travaux, *labours.*
vantail, *a leaf of a door.*	vantaux, *leaves of doors.*
vitrail, *stained glass window.*	vitraux, *stained glass windows.*

Fifth Exception.—The following nouns have two forms in the plural;—

Singular.	*Plural.*
ail, *garlic.*	aulx, ails.
pal, *pale.*	paux, pals.

The plural of **bétail**, *cattle*, is **bestiaux**; and **bercail**, *sheepfold*, has no plural.

Sixth Exception.—Nouns ending in the singular with *-al*, change that termination into *-aux* in the plural: †—

Singular.	*Plural.*
général, *general.*	généraux, *generals.*
cheval, *horse.*	chevaux, *horses.*
mal, *evil.*	maux, *evils.*

In French the change from *l* to *u* is not uncommon. It may be seen in *autre*, *paume*, *aube*, and *beau*, which correspond to the Latin alter, palma, alba, and bellum. The plural of *cheval*, and the rest, was once *chevals*, etc. This, in accordance with the change to which we have called attention, became *chevaus* or *chevaux*. In modern French *ux* is almost always found instead of *ls* in the plural of these words. A few exceptions are given in a note.

Ciel, aïeul, travail, œil, have two plurals:—

Singular.	*Plural.*
ciel, *heaven, sky.*	cieux, *heavens, skies.*
ciel, { *tester of a bed, sky of a picture, roof of a quarry, climate.*	ciels, { *testers of beds, skies of pictures, roofs of quarries, climates.*
aïeul, *ancestor.*	aïeux, *ancestors.*
aïeul, *grandfather.*	aïeuls, *grandfathers.*
travail, *labour.*	travaux, *labours*
travail, *report of a minister to the head of the State, or of the heads of departments to ministers; trave.*	travails, *reports of ministers to the head of the State, or of heads of departments to ministers; traves.*
œil, *eye.*	yeux, *eyes.*

N.B.—**Œil** *is found in many compound words, in which case it forms its plural regularly:—*

œil-de-bœuf, *oval window*	œils-de-bœuf, *oval windows.*
œil-de-chat, *cat's eye (stone).*	œils-de-chat, *cat's eyes.*

* The other nouns in *ail* form their plural by adding *s*, viz., **détail**, *detail*; **attirail**, *apparatus*; **éventail**, *fan*; **gouvernail**, *helm*; **portail**, *portal*; **sérail**, *seraglio*.

† **Bal**, *ball*; **cal**, *callosity*; **carnaval**, *carnival*; **chacal**, *jackal*; **nopal**, *nopal*; **régal**, *treat*; **serval**, *serval*; are exceptions, and take an *s* in the plural.

PLURAL OF COMPOUND NOUNS.

When two nouns form a compound substantive, both take the plural ending:—

Singular.	*Plural.*
chef-lieu, *chief place.*	chefs-lieux, *chief places.*
lieutenant-colonel, *lieutenant-colonel.*	lieutenants-colonels, *lieutenant-colonels.*

When a compound noun is formed of two substantives joined by a preposition, the first only takes the plural ending:—

Singular.	*Plural.*
arc-en-ciel, *rainbow.*	arcs-en-ciel, *rainbows.*
chef-d'œuvre, *masterpiece.*	chefs-d'œuvre, *masterpieces.*

The words **tête-à-tête**, *private conversation*, and **coq-à-l'âne**, *an incongruous discourse*, remain unchanged in the plural.

When a noun and an adjective form a compound noun, both take the mark of the plural:—

Singular.	*Plural.*
porte-cochère, *carriage-door.*	portes-cochères, *carriage-doors.*
basse-cour, *poultry-yard.*	basses-cours, *poultry-yards.*

Exception.—In the compound noun, **nouveau-né**, *first-born*, the first component is invariable; **un nouveau-né, des nouveau-nés; une nouveau-née, des nouveau-nées.**

The mark of the feminine being left out in the adjective of compound nouns consisting of the adjective **grand** and a feminine substantive *beginning with a consonant*, that of the plural is also omitted in the adjective:—

Singular.	*Plural.*
grand'mère, *grandmother.*	grand'mères, *grandmothers.*
grand'messe, *high mass.*	grand'messes, *high masses.*

The words Monsieur, *Sir*, *Mr.*, *gentleman*; Madame, *Madam*, or *Mrs.*; Mademoiselle, *Miss*, being each composed of a possessive pronoun and a noun, form their plural as follows:—

Singular.	*Plural.*
Monsieur, *Sir*, etc.	Messieurs, *Sirs, gentlemen.*
Madame, *Madam*, etc.	Mesdames, *ladies*, etc.
Mademoiselle, *Miss*, etc.	Mesdemoiselles, *young ladies*, etc.

In words composed of a verb, a preposition, or an adverb and a noun, the latter takes the form of the plural, provided, however, there is plurality in the idea:—

Singular.	*Plural.*
passe-droit, *injustice.*	passe-droits, *injustices*
avant-garde, *vanguard,*	avant-gardes, *vanguards.*

Compound nouns of which the second word indicates plurality, take *s* in the singular and plural:—

Singular.	*Plural.*
porte-cigares, *cigar-case.*	porte-cigares, *cigar-cases.*
porte-clefs, *turnkey.*	porte-clefs, *turnkeys.*

Words composed of two verbs, or of a verb joined to an adverb or a preposition, are invariable:—

Graveur, *engraver.*	Peintre, *painter.*	Médecin, *physician.*
Sculpteur, *sculptor*	Écrivain, *writer.*	Poète, *poet.*
Imprimeur, *printer.*	Docteur, *doctor.*	Auteur, *author*, etc.

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It is impossible to explain these two last exceptions on any other ground than that of custom. In early times the spelling of French words was not governed by invariable rules. Instead of *s* mute, *z* or *x* was frequently written, and as French orthography became more precise, *x* was retained in the plural of some nouns, *s* in the plural of others. The consequence of this has been the confusion which exists to-day. It is important to remember

d'un, before a masculine noun, d'une, before a feminine noun,	*of* or *from a, an.*
à un, before a masculine noun, à une, before a feminine noun,	*at* or *to a, an.*
Le père et *la* mère sont *au* désespoir. B. DE ST. PIERRE.	*The father and mother are in despair.*
*L'*amitié dans nos cœurs verse *un* bonheur paisible. DEMOUSTIER.	*Friendship pours a peaceful happiness into our hearts.*
*L'*honneur *aux* grands cœurs est plus cher que *la* vie. CORNEILLE.	*Honour is dearer than life to noble hearts.*
Les filles et *les* garçons chantèrent en chœur. B. DE ST. PIERRE.	*The boys and girls sang in chorus.*
Sur *les* rives *du* Gange on voit fleurir *l'*ébène. DELILLE.	*On the banks of the Ganges we see the ebony in bloom.*
La violette se cache timidement *au* milieu *des* filles *de l'*ombre. DELEUZE.	*The violet conceals herself timidly in the midst of the daughters of the shade.*
Le remords se réveille *au* cri *de la* nature. DE BELLOY.	*Remorse is aroused by the cry of nature.*
La moitié *des* humains vit aux dépens *de l'*autre. DESTOUCHES.	*One half of mankind lives at the expense of the other.*

THE ADJECTIVE.

The adjective serves to denote the quality or manner of being of the noun.

Adjectives are of two sorts: *qualifying adjectives* and *determinative adjectives.*

We call *qualifying adjectives* those which add to the idea of the object that of a quality proper to it: as, bon, *good:* noble, *noble;* courageux, *courageous.*

Determinative adjectives are those which add to the idea of the object a particular limitation or determination: as, quelque, *some;* tout, *all;* autre, *other;* mon, *my;* nul, *no;* un, *one;* deux, *two.*

QUALIFYING ADJECTIVES.

These adjectives may express qualities:—1. Simply. 2. With comparison. 3. Carried to a very high degree. Hence the three degrees of qualification: the positive, the comparative, and the superlative.

(1) The positive is nothing but the adjective in its simplest signification:—

Moi, je suis à Paris, *triste, pauvre, reclus.* BOILEAU.	*At Paris I am sad, poor, and secluded.*

(2) The comparative is the adjective expressing a comparison between several objects. There is, then, between the objects compared, a relation of *equality, superiority,* or *inferiority.*

In French, adjectives cannot be compared, as in English, by means of changes in the termination. With the exception of meilleur, *better;* moindre, *less:* pire, *worse,* all comparisons must be formed by means of adverbs.

The comparison of equality expresses a quality in the same degree in the objects compared. It is formed by placing aussi, *as,* or autant, *as much,* before the adjective, and the conjunction que, *as,* after it:—

L'Allemagne est *aussi* peuplée *que* la France. VOLTAIRE.	*Germany is as populous as France.*
À leur tête est le chien, superbe *autant qu'*utile. DELILLE.	*At their head stands the dog, as noble as useful.*

The relation or comparison of superiority expresses a quality in a higher degree in one object than in another. This comparison is formed by placing plus, *more,* before the adjective, and que, *than,* after it:—

Les actions sont *plus* sincères *que* les paroles. MLLE. DE SCUDERY.	*Actions are more sincere than words.*
Le pied du cerf est *mieux* fait que celui du bœuf. BUFFON.	*The foot of the stag is better formed than that of the ox.*

The comparison of inferiority expresses a quality in a lower degree in one object than in another. It is formed by placing moins, *less,* before the adjective, and que, *than,* after it:—

Le naufrage et la mort sont *moins* funestes *que* les plaisirs qui attaquent la vertu. FÉNELON.	*Shipwreck and death are less fatal than those pleasures which attack virtue.*

The adverbs *aussi, autant, plus,* and *moins* must be repeated before every adjective used in the comparative degree in the same sentence:—

Il est *plus* grand et *plus* fort que son frère, quoiqu'il soit *plus* jeune.	*He is taller and stronger than his brother, although he is younger.*

There are, as we have said, only three adjectives which are comparative of themselves—meilleur, *better:* moindre, *less;* pire, *worse.*

Meilleur, instead of *plus bon,* which is never used in the sense of *better:*—

Il n'est *meilleur* ami ni parent que soi-même. LA FONTAINE.	*We have no better friend, no better relation than ourselves.*

Pire, instead of *plus mauvais,* which may, however, be used:—

Le remède est parfois *pire* que le mal. LENOBLE.	*The remedy is at times worse than the evil.*

Moindre, instead of *plus petit,* an expression also in use:—

Ce n'est pas être petit que d'être *moindre* qu'un grand. BOISTE.	*Being less than great is not being small.*

Mieux, *better;* pis, *worse;* moins, *less.* The English words *better, worse, less,* are sometimes adverbs, and when they are so, should be rendered by the several words placed at the commencement of this paragraph. A practical way of determining the nature of these words in English is—

(*a*) To change the word *better* into the expression *in a better manner.* If this change may be made without altering the sense, the word *better* is an adverb, and must be rendered by *mieux:*—

Il lit *mieux* que son frère.	*He reads better (in a better manner) than his brother.*

(*b*) If you can change *worse* into *in a worse manner,* it should be translated by *pis,* or *plus mal:*—

Il lit pis, ou plus mal, que son frère.	*He reads worse (in a worse manner) than his brother.*

(*c*) When you may substitute *a smaller amount* or *quantity* for the word *less*, it should be rendered by *moins* :—

Il lit *moins* que son frère.	*He reads less (a smaller amount) than his brother.*

(3) The *superlative*, or third degree of qualification, expresses the quality carried to a very high, or to the highest degree. Hence there are two sorts of superlatives: the relative and the absolute.

The superlative relative marks a very high or the highest degree *relatively*; *i.e.*, with comparison. It is formed by placing **le, la, les,** *the*; **mon, ma, mes,** *my*: **ton, ta, tes,** *thy*; **son, sa, ses,** *his*: **notre, nos,** *our*; **votre, vos,** *your*; **leur, leurs,** *their*, before the comparative of superiority or inferiority :—

Un bienfait reçu est *la plus sacrée* de toutes les dettes. MME. NECKER.	*A benefit received is the most sacred of all debts.*
La probité reconnue *est le plus sûr* de tous les serments. MME. NECKER.	*Acknowledged probity is the most secure of all oaths*

The words *le plus, le moins*, must be repeated before every adjective :—

Ce sont les livres *les plus* agréables, *les plus* universellement lus, et *les plus* utiles. B. DE ST. PIERRE.	*These books are the most agreeable, the most universally read, and the most useful.*

The superlative absolute expresses also a very high degree, but, absolutely, without comparison. It is formed by placing before the adjective one of the words, *très, fort, infiniment, extrêmement*, etc. :—

Il y a à la ville, comme ailleurs, de *fort* sottes gens. LA BRUYÈRE.	*There are in cities, as elsewhere, very silly people.*
Je vous prie de croire que je ne songe qu'à vous, et que vous m'êtes *extrêmement chère*. MME. DE SÉVIGNÉ.	*I beg you to believe that you are my only thought, and that you are extremely dear to me.*

GENDER AND NUMBER OF THE ADJECTIVE.

The adjective must assume the gender and number of the noun which it qualifies.

The termination of the adjective varies according to the gender and number of the noun which it qualifies or determines :—

Masculine.	*Feminine.*
Un homme *prudent*.	Une femme *prudente*.
A prudent man.	*A prudent woman.*
Des hommes *prudents*.	Des femmes *prudentes*.
Prudent men.	*Prudent women.*

RULES FOR THE FORMATION OF THE FEMININE OF ADJECTIVES.

(1) All adjectives ending in *e* mute remain unchanged in the feminine :—

Masculine.	*Feminine.*
Un homme *agréable*.	Une femme *agréable*.
An agreeable man.	*An agreeable woman.*
Un mur *solide*.	Une maison *solide*.
A strong wall.	*A strong (well built) house.*

(2) Adjectives not ending in *e* mute form their feminine by the addition of *e* :—

Masculine.	*Feminine.*
Un garçon *diligent*.	Une fille *diligente*.
A diligent boy.	*A diligent girl.*
Un homme *poli*.	Une dame *polie*.
A polite man.	*A polite lady.*

EXCEPTIONS :—

First Exception.—Adjectives ending in *-as, -el, -eil, -en, -et, -on, -os, -ot*, form their feminine by doubling the last consonant and adding *e* :—

Masculine.	*Feminine.*	*Masculine.*	*Feminine.*
Gras, *fat.*	Grasse.	Muet, *dumb.*	Muette.
Cruel, *cruel.*	Cruelle.	Bon, *good.*	Bonne.
Vermeil, *ruddy.*	Vermeille.	Gros, *big.*	Grosse.
Chrétien, *Christian.*	Chrétienne.	Bellot, *pretty.*	Bellotte.

Although **ras**, *close-shaved, shorn*, ends in *-as*, its feminine is *rase*.

The following adjectives in *-et*, and all adjectives in *-er*, form their feminine by simply adding *e*, a grave accent being placed over the *e* preceding the final consonant :—

Masculine.	*Feminine.*
Complet, *complete.*	Complète.
Incomplet, *incomplete.*	Incomplète.
Concret, *concrete.*	Concrète.
Discret, *discreet.*	Discrète.
Indiscret, *indiscreet.*	Indiscrète
Inquiet, *uneasy.*	Inquiète.
Secret, *secret.*	Secrète.
Replet, *replete.*	Replète.
Dernier, *last.*	Dernière.
Fier, *proud.*	Fière.
Premier, *first.*	Première.
Cher, *dear.*	Chère.

The feminine of **prêt**, *ready*, is *prête*.

Second Exception.—Adjectives ending in *f* change *f* into *v* and add *e* in their feminine :—

Vif, *lively.*	Vive.	Neuf, *newly made.*	Neuve.

Third Exception.—Adjectives ending in *x* form their feminine by changing *x* into *s*, and adding *e* :—

Heureux, *happy.*	Heureuse.	Vertueux, *virtuous.*	Vertueuse.

The following, however, do not conform to this rule :—

Masculine.	*Feminine.*	*Masculine.*	*Feminine.*
Doux, *sweet.*	Douce.	Préfix, *prefixed.*	Préfixe.
Faux, *false.*	Fausse.	Roux, *red-haired.*	Rousse.

Fourth Exception.—Adjectives ending in *-eur*, derived from participles present by dropping *-ant* and substituting *-eur*, change the final *r* into *-se*; as,

Pres. Part.	*Masculine.*	*Feminine.*
flattant, *flattering.*	flatteur.	flatteuse.
trompant, *deceiving.*	trompeur.	trompeuse.

Fifth Exception.—Those ending in *-érieur*, also *majeur, mineur, meilleur*, follow the general rule, that is, add *e* to form the feminine; as,

extérieur, *exterior,*	*make in the feminine*	extérieure,
supérieur, *superior,*		supérieure,
majeur, *of age, major,*		majeure,
mineur, *minor, under age,*		mineure,
meilleur, *better,*		meilleure.

Sixth Exception.—The following adjectives having two forms for the masculine, form their feminine as follows:—

Masculine.		*Feminine.*	
beau,*	bel,	belle,	*handsome.*
fou,	fol,	folle,	*foolish.*
mou,	mol,	molle,	*soft.*
nouveau,	nouvel,	nouvelle,	*new.*
vieux,	vieil,	vieille,	*old.*

TRANSLATION FROM FRENCH.

Paul de Gondi, afterwards Cardinal de Retz, was born in 1614. Like his contemporary La Rochefoucauld, of whom he has given us a sketch, he was a member of the party of the *Fronde.* Though by profession an ecclesiastic, he could never abstain from political intrigues. In 1652 he was thrown into the Bastille by Mazarin, and was afterwards confined in the Castle of Nantes. He managed to escape, however, and spent many years in exile. In 1679 he died. His best known work is his "Mémoires," from which we give an extract here.

LA ROCHEFOUCAULD.

Il y a toujours eu dû je ne sais quoi en tout M. de la Rochefoucauld. Il a voulu se mêler d'intrigues dès son enfance, dans un temps où il ne sentait pas les petits intérêts, qui n'ont jamais été son faible, et où il ne connaissait pas les grands, qui d'un autre sens n'ont pas été son fort. Il n'a jamais été capable d'aucune affaire, et je ne sais pourquoi; car il avait des qualités qui eussent suppléé en tout autre celles qu'il n'avait pas. Sa vue n'était pas etendue, et il ne voyait pas même tout ensemble ce qui était à sa portée; mais son bon sens, et très-bon dans la spéculation, joint à sa douceur, à son insinuation et à sa facilité de mœurs qui fut admirable, devait compenser plus qu'il n'a fait le défaut de sa pénétration. Il a toujours eu une irrésolution habituelle; mais je ne sais même à quoi attribuer cette irrésolution. Elle n'a pu venir en lui de la fécondité de son imagination, qui n'est rien moins que vive; je ne la puis donner à la stérilité de son jugement; car, quoiqu'il ne l'ait pas exquis dans l'action, il a un bon fonds de raison. Nous voyons les effets de cette irrésolution, quoique nous n'en connaissons pas la cause. Il n'a jamais été guerrier quoiqu'il fût très-soldat. Il n'a jamais été par lui-même bon courtisan quoiqu'il ait eu toujours bonne intention de l'être. Il n' jamais été bon homme de parti, quoique toute sa vie il y ait été engagé. Cet air de honte et de timidité que vous lui voyez dans la vie civile s'était tourné dans les affaires en air d'apologie; il croyait toujours en avoir besoin: ce qui, joint à ses *Maximes*, qui ne marquent pas assez de foi à la vertu et à sa pratique, qui a toujours été de chercher à sortir des affaires avec autant d'impatience qu'il y était entré, me fait conclure qu'il eût beaucoup mieux fait de se connaître et de se réduire à passer, comme il l'eût pu, pour le courtisan le plus poli, et pour le plus honnête homme, à l'égard de la vie commune, qui eût paru dans son siècle.

* The forms *beau*, *fou*, *mou*, *nouveau*, and *vieux*, are used before words masculine beginning with a consonant or sounded *h*; and *bel*, *fol*, *mol*, *nouvel*, and *viel* before words masculine beginning with a vowel or silent *h*; *e.g.*, *un beau cheval*, *fol espoir*, *vieil ami*, *vieux pont*, etc.

KEY TO TRANSLATION (p. 352).

MEN AND ANIMALS.

There are varied species of men as there are varied species of animals . . . There are birds which are only to be commended for their singing and their colour. How many parrots there are who chatter without ceasing, and who never understand what they say! How many magpies and rooks who are only made tame in order to rob! How many birds of prey who only live by plunder! How many peaceful and quiet animals whose only use is to feed other animals! There are cats, always on the watch, malicious and unfaithful, who make their paws like velvet; there are vipers whose tongue is venomous . . . . and there are owls which fear the light. How many horses are there which we employ in so much work, and which we abandon when they are no longer of any use! How many oxen who work all their lives to enrich him who puts the yoke on them; of grasshoppers who pass their lives in singing; hares who fear everything; swallows who always follow fine weather; giddy and thoughtless cockchafers; butterflies who seek the fire in which they will be burnt! How many hornets, wanderers and idlers, who claim to exist at the expense of bees! How many ants whose foresight satisfies all their wants! How many crocodiles who pretend to complain in order to devour those who are touched by their complaints! and how many animals who are in subjection, because they do not know their strength!

GEOGRAPHY.—XIX.

[*Continued from Vol. III., p. 340.*]

AFRICA (*continued*).

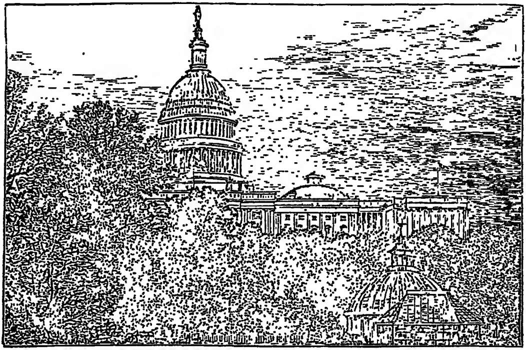
IN the north-east are EGYPT and TRIPOLI, more or less parts of the Turkish Empire (*see* Vol. III., p. 318); TUNIS and ALGERIA, similarly connected with France (*see* Vol. II., p. 371); and MOROCCO. MOROCCO, estimated at 219,000 square miles, with a population of some five millions, is under a Mohammedan military despotism. Fez [120], and *Mequinez* [56], in the north, and *Morocco* [50] in the south, manufacture leather, and Fez, red cloth caps. *Tangier* on the Straits of Gibraltar, and *Mogador* on the west coast, are the chief ports.

South-west of the Sahara are SENEGAMBIA, including French SENEGAL (Vol. II., p. 371) and the British territories of GAMBIA and SIERRA LEONE (Vol. II., p. 144), with the Portuguese settlements

Bissao and Casamanza between them; much independent territory inland; and the negro republic of Liberia. LIBERIA, 48,000 square miles, with a population of one and a half millions, including 25,000 descendants of American slaves, was founded by American philanthropists in 1822. It was formerly known as the Grain or Pepper Coast, from

in the east, with NUBIA, to the north, in which the chief town is Dongola, on the Nile, and the EQUATORIAL PROVINCE, chief town Gondokoro, on the White Nile, all till quite recently under the Egyptian Government, but now under the Khalifa, the successor to the Mahdi.

East of Senaar is the Italian protectorate of



THE CAPITOL, WASHINGTON.

the export of grains of paradise and pepper. Palm-oil, rubber, ivory, and coffee are among the chief exports. Monrovia [6].

Along the north of the Gulf of Guinea eastward extends UPPER GUINEA, or the IVORY, GOLD, and SLAVE COASTS, the former with the French colonies of ASSINI and GRAND BASSAM, the GOLD COAST, British (Vol. II., p. 144), and the latter with the British settlement of LAGOS, the German TOGOLAND (see p. 64), and the native state of DAHOMEY, capital Abomey. North of the Gold Coast is ASHANTILAND, capital Coomassie, under British rule.

East of Senegambia extends the SOUDAN, with the negro states of BAMBARRA, capital Sego, MOASSINA, capital Timbuktu, and GANDO, capital Boussa, where Mungo Park died, in the west, on the Niger; SOKOTO, ADAMAUA, BORNU, capital Kuka, BAGIRMI, and WADAI, in the centre; and DARFUR, KORDOFAN, capital El Obeid, and SENAAR,

ERITREA (see Vol. III., p. 252), and south of the Gulf of Aden is the dry SOMALILAND, under German protection, with the exception of the British ports of *Zeylah* and *Berbera*. West of this the GALLAS country extends to Victoria Nyanza, between which and the Albert Nyanza are UGANDA and UNYORO. ZANZIBAR, under British rule, extends from *Warsheik* in lat. 2° 30′ N. to CAPE DELGADO, at the mouth of the *Rovuma River*. Zanzibar, on an island, exports copal, ivory, cloves, etc. The northern part of the inland territory to Kilimanjaro, with the port of *Mombasa*, is under British, the southern part, with *Port Durnford*, under German protection.

From Cape Delgado to Delagoa Bay is the Portuguese province of MOZAMBIQUE (see Vol. III., p. 250), with the towns of *Mozambique* and *Sofala*, and *Quilimane* at the mouth of the Zambesi. In the interior British missionaries have made a road between Lakes Tanganyika and Nyassa, at the south of

which is the mission-station of *Livingstonia*, and have steamers on the Shiré river, which drains Lakes Nyassa and *Shirwa*, south of which is the station of *Blantyre*, and enters the Zambesi, 90 miles above its mouth.

This district south of a line westward from the north shore of Lake Shirwa to the *Lisungwe River*, a tributary of the Shiré, west of a line from the east shore of the lake, and north of the *River Ruo*, has been declared a British protectorate under the name of MAKOLOLOLAND. The British Government urge that the navigation of the Shiré and Zambesi should be free to all nations, and have declared MASHONALAND, in the interior between that river and the *Limpopo*, and MATABELELAND, farther west, between the Zambesi and Bechuanaland, to be also under British protection.

Surrounded by British territory in the south are the Boer ORANGE RIVER FREE STATE and ZULU REPUBLIC ("Nieuwe Republiek"). (*See* Vol. II., pp. 143–4.) From the mouth of the Orange River northwards, the German LÜDERITZLAND (*see* Vol. III., p. 61), capital **Lüderitz Bight**, formerly Angra Pequena, extends to the British WALFISCH BAY; north of which, DAMARALAND, also German, extends to Cape Frio. From Cape Frio to the Congo is Portuguese LOWER GUINEA, including BENGUELA, with the ports of **Benguela** and *Mossamedes*, and ANGOLA, with **Loanda** and *Ambriz*, and the south bank of the Congo for ninety miles from its mouth. Near the coast all these provinces are arid, but inland there is a rich plateau yielding coffee, cotton, sugar, rubber, and in the north palm-oil.

THE CONGO FREE STATE, constituted in 1885, with an estimated area of 802,000 square miles, and a population of 8 millions, with the King of the Belgians as sovereign, but bound by treaty to free trade principles, extends eastward to Lake Tanganyika. The chief stations are *Boma* and *Léopoldville*, on Stanley Pool; and the chief exports palm-oil, ground-nuts, rubber, coffee, and ivory.

North of the Congo are the French settlements of OGOWE and the GABOON, and the German settlements of the CAMEROONS, on the Bight of Biafra, opposite the Spanish island of *Fernando Po*.

NORTH AMERICA.

AMERICA or the New World is as truly two united continents as are Asia and Europe, and more so than Asia and Africa. North and South America have, however, one continuous mountain axis, and, apparently, one aboriginal stock of inhabitants, now forming, however, less than a quarter of the entire population.

Position and Coast-line.—NORTH AMERICA contains about 8½ million square miles, or 2¼ the area of Europe, one million being islands, chiefly those in the Arctic Ocean and the West Indies in the south-east. The coastline exceeds 24,000 miles, or one mile to every 312 square miles of area, more than that of any continent except Europe. Of the mainland, *Murchison Promontory* in *Boothia Felix*, in lat. 72°, is the northernmost point; *Cape Prince of Wales*, in *Alaska*, on *Behring Strait*, in long. 168° W., the westernmost; and *Cape Charles*, in *Labrador*, in long. 55° 40′ W., the easternmost. The central parallel, that of 41° N., is approximately that of *Salt Lake*, *New York*, Naples, Constantinople, and Khiva; and the *Isthmus of Panama* is in the latitude of the south of India. The greatest length of the continent from north to south is about 5,600 miles; from east to west about 3,120 miles. In the Arctic Ocean, *Greenland* is separated by *Davis Strait* and *Baffin Bay* from *Baffin Land*, and by *Smith Sound* from the northernmost *Grinnell Land*: from Baffin Bay westward, *Lancaster Sound* and *Barrow Strait*, south of the *Parry Islands*, and *Melville Sound* and *Banks Strait*, south of *Melville Island*, form the almost impassable "North-west Passage;" and *Hudson Bay*, with its south-east inlet *James Bay*, is a great inland sea, entered by *Hudson Strait*, between Labrador and Baffin Land, but frozen during most of the year. On the east coast, south of Cape Charles, is *Newfoundland* (of which the easternmost point is *Cape Race*) separated from the mainland by the *Strait of Belle Isle*, which leads into the *Gulf of St. Lawrence*, in which are the islands *Anticosti*, *Prince Edward's Isle*, and *Cape Breton*. South of the *Strait of Canso* is the peninsula of *Nova Scotia* (the south point of which is *Cape Sable*) with the *Isthmus of Chignecto*, eight miles wide, and the *Bay of Fundy* between it and *New Brunswick*. *Cape Cod*, south of *Massachusetts Bay*: *Long Island*, opposite *New York*: *Delaware* and *Chesapeake Bays*; *Cape Hatteras*, east of *North Carolina*; and the second *Cape Sable*, the south point of *Florida*, are on the east coast of the *United States*. The *Bermudas* (*see* Vol. II., p. 241) lie 580 miles east of Cape Hatteras; the *Bahamas* to the east, and *Cuba* to the south, of Florida, separated by *Florida Channel*, through which the *Gulf Stream* leaves the Gulf of Mexico (*see* Vol I., p. 261). The *Gulf of Mexico* lies to the south of the United States, and east and north of *Mexico*, its south-western portion, *Campeachy Bay*, having the *Isthmus of Tehuantepec*, 130 miles across, to the south, and the *Yucatan Peninsula* to the east. This peninsula, ending north-eastward in *Cape Catoche*, is separated from Cuba by the *Yucatan Channel*, communicating with the *Caribbean Sea*,

This sea is encircled by the *Greater Antilles* to the north; by the *Lesser Antilles* to the east (*see* Vol. II., p. 241): by South America with the Isthmus of Panama to the south; and by the Central American Republics of *Costa Rica*, *Nicaragua*, *Honduras*, and *Guatemala*, north of which is the *Gulf of Honduras*. *British Honduras*, and *Yucatan* on the west. On the west, *Point Barrow* is the northernmost point of Alaska: *Behring Strait*, 36 miles across, separates North America from Asia; the peninsula of *Alaska* terminates in the chain of *Aleutian Isles*, which stretch, south of *Behring Sea*, almost to Kamchatka; another chain of islands extends down the coast to the British *Queen Charlotte's* and *Vancouver Islands* and the *Straits of San Juan de Fuca*. South of this the coast of the United States extends to *Lower California*, which peninsula, separated from the mainland by the *Gulf of California*, belongs to Mexico and terminates in *Cape St. Lucas*; and to the south of Mexico is the *Bay of Tehuantepec*.

Surface and Drainage.—Physically North America is divided into four main regions—the Western Highland; the Central Plain; the Eastern Highland; and the Atlantic Plain. The *Western Highland*, or *Cordilleras*, extends from the mountains of Alaska, where *Mount Wrangell* (20,000 feet) is the highest known peak in the continent, with the *Rocky Mountains* as its eastern edge, with *Mount Brown* (16,000 feet) and *Mount Hooker* (15,690 feet) in British Columbia, to the *Sierra Madre* of Utah and Arizona, widening out into the plateau of Mexico, 7,000 feet high. At the southern edge of this plateau is a chain of volcanoes, including *Popocatepetl* (17,794 feet), *Orizaba* (17,660 feet), and *Jorullo*. The western edge of the highland is the *Pacific Range*, extending from Mount Wrangell and the active volcano *Mount St. Elias* (19,500 feet) on the frontier of Alaska, through the islands, to the *Cascade Range* of Washington and Oregon, with *Mount Hood* (12,226 feet) and the beautiful *Mount Shasta* (14,450 feet). To the south the two parallel lines of the *Coast Range* and the *Sierra Nevada* are divided by the fruitful valley of California, the northern part of which is the valley of the *Sacramento*, flowing into *San Francisco Harbour*. The northern part of this highland is drained by the *Yukon* and *Fraser Rivers*, the former of which pours a volume 1½ times that of the Mississippi. The almost rainless *Great Basin*, a desert plateau between 4,000 and 7,000 feet high, between the Cascade Range and the Sierra Nevada on the one side and the Rocky Mountains on the other, drains partly northward by the *Snake River*, a tributary of the *Columbia*, partly into inland lakes, of which *Great Salt Lake* (1,800 square miles, at an altitude of 4,210 feet) is the chief, and partly southward by the *Rio Colorado* into the Gulf of California and by the *Rio Grande* into the Gulf of Mexico. The *Central Plain* extends from the Arctic Ocean to the Gulf of Mexico, and from the Rocky to the *Appalachian Mountains*. At about 49° N. lat., the boundary between Canada and the western United States, a watershed reaching 1,500 feet forms "the Great Divide," separating the *Arctic Plain*, draining northward by the *Mackenzie*, *Churchill*, and *Nelson*, and north-eastward by the *St. Lawrence* (*see* Vol. II., pp. 238-9), from the *basin of the Mississippi*. The Arctic Plain is, as we have previously seen, a region of numerous large freshwater lakes. The *Mississippi* (4,200 miles) nominally rises in *Lake Itasca* in *Minnesota*, west of Lake Superior, flowing over the *Falls of St. Anthony*, southward to St. Louis; but here it receives the far longer *Missouri* which has already traversed 2,500 miles from its source in the Rocky Mountains of *Montana*, which is near that of its tributary the *Yellowstone*, in the *Yellowstone National Park*. The chief other tributary of the Missouri is the *Nebraska*, also from the west. Below St. Louis the Mississippi receives the *Ohio*, of which the *Tennessee* is a southern tributary, from the east, and the *Arkansas* and *Red Rivers* from the west. The main stream is navigable from St. Paul in Minnesota. Nearly the whole Mississippi basin (1,257,547 square miles) consists of gently undulating treeless prairies. The west part of the *Great Plains* rising at the foot of the Rocky Mountains to 6,000 feet is an almost rainless arid desert, with little vegetation but the sage-bush (*Artemisia*) or, farther south, the cactuses. The prairie-dog burrows in these dry plains, and rapidly dwindling herds of bison, the so-called buffalo, feed on the grassy tracts. East of the Mississippi the land is now almost all under cultivation. In the south are swamps liable to inundation by the river, on which grow the deciduous cypress (*Taxodium*) and the pitch-pine. The *Eastern Highland* or *Appalachian Mountains* consists of several parallel chains, mostly less than 3,000 feet in height, extending from Georgia to the Gulf of St. Lawrence, to the southernmost of which properly belongs the name *Alleghany Mountains* often applied to the whole. The valley of the *River Hudson* cuts through the northern part of the Appalachians, and, being united to Lake Erie by the Erie Canal and by another canal to Lake Champlain and the St. Lawrence, forms a most important water-way. The mountains are well wooded, as was formerly the *Atlantic Plain* to the east of them. This plain merges in the Central Plain in the south, where it contains numerous swamps and, in the interior, "pine-barrens," sandy tracts yielding pitch-pine. It is crossed by numerous rivers flowing into the Atlantic, among which are

the *Connecticut*, *Hudson*, *Delaware*, *Susquehanna*, *Potomac*, and *Savannah*, each about 400 miles in length, and by the *Alabama*, flowing southward into the Gulf of Mexico.

Climate and Productions.—The Arctic plain, unprotected from the north, is extremely cold, icy winds sometimes sweeping down even to the Gulf of Mexico. The Pacific coast is mild, the harbours of British Columbia never freezing; but the Japan Current not being as warm as the Gulf Stream, it is not so mild as corresponding latitudes in Western Europe. Similarly the climate of the Atlantic coast, though extreme or continental, is not so severe as that of Eastern Asia. The elevated region of the United States between long. 100° and 120° W. is subject to monsoon winds, but has its rainfall so largely intercepted by the mountains to the west as to be too arid for agriculture without irrigation. Round the Gulf of Mexico, which is bisected by the Tropic of Cancer, heat almost tropical prevails, and yellow fever is frequent. The West Highland is rich in precious metals: gold in British Columbia and California; silver in Nevada and Mexico. Copper is abundant near Lake Superior, and coal and iron especially in Pennsylvania and along the west of the entire Appalachian range. Pennsylvania also yields the chief supply of petroleum in the world. Timber is now most abundant in the south of Canada, where the hemlock-spruce is the most important species; in the south-eastern United States, which yield pitch-pine; and in California, Oregon, Washington, and British Columbia, where the mammoth-tree and redwood (*Sequoia*) and the Douglas fir are specially noteworthy. Wheat is cultivated on an enormous scale, especially in the region of the Great Divide, and maize farther south; the grape for wine-making and every variety of southern fruit, in California; tobacco, in most of the United States; cotton, in those bordering the Lower Mississippi; the sugar-cane, in Louisiana; rice, in Carolina; and oranges, in Florida. Mahogany, logwood, coffee, tobacco, sugar, rum, and ginger are, as we have seen, among the chief products of the West Indies and other tropical regions. The cod fishery off Newfoundland, and the salmon of the Columbia and Fraser Rivers, furnish important industries. The reindeer of the north was the only indigenous American animal yielding milk; but there are, especially in the north, a great variety of fur-yielding animals, including seals in Alaska, polar bears, grizzly bears in the Rocky Mountains, moose and beaver in Canada. The puma and the rattle-snake are characteristic.

Political Divisions.—North America is politically divided between thirteen powers, which, with their areas, ratios to Great Britain, and populations, are given in the following table:—

	Area in sq. miles.	Ratio to Gt. Brit.	Population.
Danish America, including Greenland and some West Indian Islands - - - -	75,000	5¾	127,000
British North America - -	3,888,000	44	5,500,000
United States - - - - - -	3,730,000	41	64,000,000
Mexico - - - - - - -	751,000	8⅓	10,400,000
Guatemala - - - - - - -	46,000	½	1,500,000
San Salvador - - - - - -	7,000	1/12	750,000
Honduras - - - - - - -	42,000	½	398,000
Nicaragua - - - - - - -	51,000	⅗	310,000
Costa Rica - - - - - - -	23,000	¼	243,000
Hayti - - - - - - - - -	20,000	1/11	1,200,000
San Domingo - - - - - -	20,000	¼	500,000
French West Indies, including Guadaloupe and Martinique - - - - - - -	900,000	1/80	360,000

THE UNITED STATES.

Physical Features.—The Federal Republic of the United States of America consists of forty-four "sovereign" states, a federal district, and five organised territories, occupying the central portion of North America from the Atlantic to the Pacific, or from long. 67° W. to 124° 30′ W., and between lat. 25° and 49° N., besides the outlying territory of *Alaska* in the extreme north-west of the continent, west of the meridian of 141° W., purchased from Russia in 1867. The Dominion of Canada forms the entire northern boundary of the main area, as we have seen (Vol. II., p. 145). On the south the United States are separated from Mexico by an artificial line in the west passing some miles north of the *Peninsula* and *Gulf of California*, and in the east by the *Rio Grande* to its outlet into the *Gulf of Mexico*. The area is estimated at 3,581,885 square miles, excluding Cuba and Porto Rico. The coast-line is estimated at 13,200 miles, besides 3,620 miles on the great lakes. Most of the general physical features of the country have been already described. More than half its area drains into the Gulf of Mexico, with a very low gradient, the head-waters of the *Mississippi* being only about 1,500 feet; Pittsburg, at the junction of the *Alleghany* and *Monongahela* to form the *Ohio*, 2,000 miles from the Gulf, 700 feet; St. Paul, in Minnesota, almost as far from the mouth, even less in altitude; St. Louis, 1,250 miles, 400 feet; and Cairo, 1,100 miles, only 300 feet above the sea-level. Both the Eastern and Western Highlands consist of various chains *en échelon*; but the passes of the *Rocky*

Mountains, several of which are now traversed by railroads, are elevated. Whilst both San Francisco and New York have a mean annual temperature of 56° Fahr., the former has a summer temperature of 60° and a winter one of 51°, and the latter a summer one of 76° and a winter one of 36°. In rainfall the country is divided into two almost equal portions by the meridian of 100° W.; the eastern half having sufficient, the western half, at least as far as the western edge of the Cordilleras, being at least so arid as to necessitate irrigation. In the north-eastern (*New England*) states sugar is obtained from the maple, and hay and potatoes are grown. In all states east of the Mississippi and north of the Ohio grain is largely grown, both maize and wheat, especially in *Illinois, Indiana, Ohio, Michigan, Minnesota*, and in *Iowa*, maize extending into *Missouri* and *Kansas*; and in the maize districts swine are largely fed. The south of Illinois, the chief prairie state, from the fertility of its rich black humus, is called "Egypt." Sheep are kept mainly in the north-central states, and cattle are fed west of the Mississippi. Tobacco cultivation is mainly south of the Ohio, especially in *Kentucky* and *Virginia*; cotton cultivation, entirely south of 37° N. lat.; cane-sugar, mainly in *Louisiana*; and, as we have seen, rice in *Carolina* and oranges in *Florida*. *California*, in addition to its wine and fruits, is a great wheat-producing state. Timber is mainly produced on the Sierra Nevada and Cascade ranges in the west, where it is shipped from *Puget Sound* in the north of *Washington*; in *Michigan*, whence it travels by way of *Chicago* and *Buffalo*; and in the pine-barrens of *North Carolina*. Among minerals iron and coal are the most valuable products of the republic, forming together five-sixths of the entire value of the minerals raised. Over 95 million tons of coal and 6 million tons of iron are now raised annually, more than half of which, together with most of the petroleum supply, comes from *Pennsylvania*, one-third of which state is made up of coal-fields. Their output is about one-eighth of that of the world. This chief coal region extends down the west side of the Appalachian range to *Georgia* and *Alabama*, and the total area of coal-fields in the United States is said to be twenty times that of those in Europe. Silver is chiefly obtained in *Nevada*, where the Comstock lode is the richest in the world, and in *Utah*, *Colorado*, and *Montana*; gold, mainly in *California*, but also in these states; copper in *Montana* and round Lake Superior; lead in *Colorado*, *Utah*, and *Missouri*.

Population and Industries.—The population, calculated at 62 millions, includes 7 million negroes, mainly in the south, 358,000 Indians, and 107,000 Chinese, mainly in the west, nearly 2½ million Germans, and as many Irish, and 13 million natives born of foreign parents. Agriculture is still the leading industry of the country, employing more than half the working population, or more than twice as many as are engaged in manufactures, mining, and mechanical arts. Manufactures are carried on chiefly in the north-eastern states, where labour, fuel, and water-power are abundant, *Massachusetts*, *Rhode Island*, *Connecticut*, *New York*, *Pennsylvania*, *Ohio*, and *Michigan* being the chief manufacturing states, and *New York*, *Philadelphia*, *Chicago*, *Boston*, *Baltimore*, *Cincinnati*, *Brooklyn*, *St. Louis*, *Pittsburg*, and *San Francisco*, the ten towns employing the largest number of persons in manufactures. Cottons, woollens, boots, tools, and machinery, mainly for home consumption, are the chief articles of manufacture. Corn occupies 81 million acres, yielding 226,000 million bushels, an average of 28 bushels per acre; wheat 31 million acres, yielding 427 million bushels, or 12 bushels per acre; but whilst the maize is mainly for home consumption, one-third of the wheat grown is exported. The chief articles exported are agricultural produce and raw materials; the principal export ports being *New York*, doing nearly half the trade, *New Orleans* (12 per cent.), *Boston* (8 per cent.), *Baltimore* (5 per cent.), *Philadelphia*, and *San Francisco*. Great Britain receives more than half of these exports, being dependent upon the United States for from one-half to two-thirds of the raw cotton, flour, wheat, maize, and live cattle, and for nearly four-fifths of the meat imported by her. Other chief exports to Britain are petroleum, cheese, copper, leather, tobacco, lard, and timber. The chief imports, nearly a quarter of which are from England, are metals, woollen, cotton, and linen in a manufactured state, French silk, and tea from China and Japan. *New York* receives over 65 per cent. of the imports; *Boston*, 9; *San Francisco* and *Philadelphia*, 5 each.

Inland Communication.—The water communication is unequalled. The great lakes and the *St. Lawrence* afford an outlet for the produce of Chicago and of the northern states, especially grain and timber; and by the *Erie Canal* and *River Hudson* they are brought to New York. Other canals connect the lakes with the great *Mississippi* system. There are about 180,000 miles of railway, or nearly half the entire length in the world, the great Atlantic ports and *New Orleans* being connected by various lines with *Chicago* and *St. Louis*, from the former of which cities the Central Pacific route runs by *Omaha* (Nebraska), *Cheyenne* (Wyoming), and *Salt Lake* (Utah) to *San Francisco*: whilst from the latter the Kansas Pacific runs to *Denver* (Colorado).

Government, etc.—The government is a federal republic, each of the forty-five states controlling its own affairs, having an elected governor and legislature of two houses. The general government of the federation is carried on by a president elected for four years, a supreme court of nine justices holding office for life, and a congress. Congress consists of the Senate of two members elected by each state, 90 in all, and the House of Representatives, now 357, one member being elected for every 174,325 of the population. The *District of Columbia*, 70 square miles, including the federal capital Washington, is not in any state, but directly under the central government, as is also the unorganised territory of *Alaska* and the military control of the independent *Indian Territory*.

The five organised territories are not admissible as independent states until their population reaches the above-stated minimum number of electors for a representative.

The revenue amounts to 63 millions sterling, and is less than the national expenditure: the debt is 200 millions. The standing army only numbers 27,000, and the navy includes 90 vessels. Education is under the control of each state, and is generally efficient, and well endowed with state lands. Harvard College, forming the University of Cambridge (Massachusetts), and Yale College, New Haven (Connecticut), are the most noted colleges in the States. There is no state religion, Methodist, Baptist, and other Protestant bodies having some 10 million professing members, whilst there are about 7 million Catholics.

BOOK-KEEPING.—XI.

[*Continued from Vol. III., p. 372.*]

JOURNAL (*continued*).

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£	s.	d.				£	s.	d.
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1	5	-	38	Stephen White (Loan a/c), Dr.				
				To Interest and Discount	40	1	5	-
				For Interest accrued due from him.				
				31 March, 1898.				
(4,529	10	4)		(*The journalising of the Goods, Cash, and Bill Books for March is similar to that for the previous months.*)		(4,529	10	4)
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				To Commission	41	10	6	-
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21,996	17	8				21,996	17	8
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				To John Loader, Rugby	17	-	7	4
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[*Continued from Vol. III., p. 372.*]

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23,997	6	2		Carried forward		23,997	6	2

the profit and loss account; or transfers to form a similar account of the liabilities and assets of the business, called a balance account.

The journal would be posted once a month only, except when there are any special entries, as, for instance, the entry on the 12th of March. These special entries, at least whenever they affect any of the personal accounts of the business, are to be made in the journal on the day when the event they record occurs, or any error they correct is discovered, and they are to be posted into the ledger at once.

The two sets of money columns in the journal—one for debits and one for credits—should be kept added, each into its own total, for the half-year or other period intervening between the balancing and closing of the books. Inasmuch as the debits and credits, mentioned or referred to in the journal during any period, are transcribed into the ledger, and the ledger can contain no others, the total of all sums entered in the debit column of the journal should agree exactly with the total of all the sums entered in the debit columns of the ledger, and likewise the total of the credit column of the journal with the total of the credit columns in the ledger. In this way the omission to post into the ledger any one or more of the amounts appearing in the journal, or the error of posting the same amount twice over, or any inaccuracy in the amount posted, may be discovered with a sureness little short of practical certainty. Moreover this test of the correctness of the posting, in common with any other that ensures, or tends to ensure the accuracy of the ledger, makes the balancing of the ledger so much the more easy and certain whenever it is required to be performed.

The plan upon which the contracted entries in the journal are framed will probably have been understood. It will have been observed that if one account is debtor to a number of others, *e.g.*, cash debtor to various accounts for receipt of cash; or if, on the other hand, a number of other accounts are debtor to cash, *e.g.*, various accounts to cash for payments of cash, then the whole group of items in the one case or the other is collected into one general journal entry.

In concluding our observations on the journal we may mention that various proposals have been put forward for abolishing it. The fact that it is, in effect, a mere repetition of the subsidiary books, and, more especially, the fact that all transactions affecting personal accounts are frequently posted to those accounts by direct posting from the subsidiary books, and before the journal is made up, have naturally led to the conclusion that it may be done away with altogether. No doubt, the postings to personal accounts are the large proportion of the entire postings, and, no doubt, the summary, showing the monthly totals to be posted to nominal accounts, may be recorded in each subsidiary book, instead of in a journal, but whether the summary is written in one book or the other makes little real difference. A separate book, as a journal, is more handy for reference, and, where several persons are employed in keeping the books, each having his own in constant use, the advantage of the separate journal is obvious.

CHEMISTRY.—V.

[*Continued from p. 5.*]

WATER (*continued*): ACTION OF WATER ON LEAD—THE ORGANIC MATTER IN WATER—COMPOSITION OF A HARD AND A SOFT WATER—NITROGEN.—THE ATMOSPHERE: UNIFORMITY OF THE AIR—ESTIMATION OF THE OXYGEN, CARBONIC ACID, AND AQUEOUS VAPOUR.

DISTILLED water and rain-water should not be kept in lead cisterns or conveyed through lead pipes, because that metal is acted upon by pure water, which dissolves and converts it eventually into lead carbonate. Although the quantity of lead contained in one day's consumption of water is small, the continued daily doses of lead accumulate in the system until dangerously poisonous effects are produced. Thames water and most river-waters and springs in the south of England do not act upon lead, in consequence, it is believed, of the mineral matter (phosphates, silica, carbonates, etc.) which they contain: some of the soft waters used for drinking purposes have, however, occasionally produced symptoms of lead-poisoning, and so with all such soft waters it is best to avoid the use of lead, and have slate cisterns and iron pipes.

Spring and river waters almost always contain dissolved organic matter. This may be derived from vegetable sources (peat, aquatic plants, etc.), and is then usually quite harmless. In many cases, especially with water from shallow wells, the organic matter is derived from animal sources, owing to the percolation of sewage. If the sewage contains the excreta of persons suffering from cholera or typhoid fever, a small quantity of this sewage is sufficient to render the water highly dangerous, and it is generally admitted that many serious epidemics have arisen in this way.

The accurate estimation of the organic matter, and especially of the organic matter containing nitrogen, in drinking water is therefore of the greatest importance.

An extremely simple practical test to apply to a drinking water is to place about a pint of the water in a very carefully cleaned bottle holding about a quart, which is then corked up and immersed in hot water until the bottle and its contents are lukewarm. It is then shaken violently and the nose immediately applied to the uncorked bottle; if the water is good, no putrid or unpleasant odour should be perceived.

As all sewage contains ordinary salt (NaCl), an undue amount of salt should always be looked upon with suspicion unless accounted for by the neighbourhood of the sea, salt-mines, etc.

PEROXIDE OF HYDROGEN OR HYDROXYL—PREPARATION—PROPERTIES—TEST.

Another oxide of hydrogen is known: it is a colourless syrupy fluid called peroxide of hydrogen, having the formula H_2O_2. It is prepared by treating barium peroxide (*see* Oxygen, Vol. III., p. 260), with dilute hydrochloric, or sulphuric acid or carbonic acid,

$$\underbrace{BaO_2}_{\text{Peroxide of barium.}} + \underbrace{H_2SO_4}_{\text{Sulphuric acid.}} = \underbrace{BaSO_4}_{\text{Barium sulphate.}} + \underbrace{H_2O_2}_{\text{Peroxide of hydrogen.}}$$

the barium sulphate settles as a white insoluble powder, and a dilute solution of peroxide of hydrogen is obtained. This dilute solution is concentrated by placing it in a dish over strong sulphuric acid in a vacuum produced by an air-pump. Sulphuric acid absorbs water readily, and so the water vapour passes into the vacuum, and is then absorbed by the acid. Peroxide of hydrogen is a powerful oxidising substance, it bleaches vegetable colours and the hair (dilute solutions turn the hair yellow); it also whitens paint which has been darkened by the sulphur from coal and gas, turning the black sulphide of lead PbS into white sulphate $PbSO_4$

$$PbS + 4H_2O_2 = PbSO_4 + 4H_2O.$$

When heated, peroxide of hydrogen gives off oxygen, and is converted into water. It gives a blue colour with chromic acid. This blue colour is soluble in ether, so that if we shake up a liquid containing peroxide of hydrogen with a little chromic acid and ether, the ether as it rises to the top is coloured blue. Peroxide of hydrogen is the principal active ingredient in the disinfectant sold as "Sanitas."

NITROGEN (Symbol N, At. w. 14)—PREPARATION—PROPERTIES.

Nitrogen is a colourless gas; it forms a large portion of the atmosphere, five volumes of air containing about four volumes of nitrogen.

It is usually prepared from the atmosphere by depriving it of its oxygen.

The simplest plan is to light a piece of dry phosphorus in a small porcelain crucible floating on some water, and then invert over the burning phosphorus a cylinder of air (Fig. 15). The phosphorus continues to burn in the cylinder of air until all the oxygen is exhausted. The fumes of the P_2O_5 (*see* Oxygen, p. 259) are allowed to settle and dissolve in the water. We then find that the water has risen in the jar, and we have a colourless gas left occupying four-fifths of the original volume of the air: if we place a glass plate over the mouth of the jar, invert it and introduce a lighted taper, the taper will be extinguished; nitrogen, therefore, does not support combustion, and does not burn.

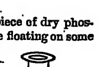

Fig. 15.

Another method of preparing nitrogen is to pass

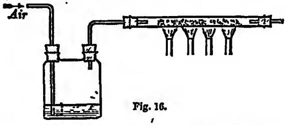

Fig. 16.

air through a glass tube containing red-hot copper turnings, when the red-hot copper combines with the oxygen, forming black oxide of copper, and the nitrogen passes on. The removal of the oxygen is greatly accelerated by bubbling the air through a strong solution of ammonia before passing it over the red-hot copper (*see* Fig. 16).

Another plan of obtaining pure nitrogen is to boil a solution of ammonium nitrite.

$$\underbrace{NH_4NO_2}_{\text{Ammonium nitrite.}} = 2N + 2H_2O$$

Nitrogen is a colourless, odourless gas which neither burns nor supports combustion. It is very inactive, and only combines *directly* with a few elements, *e.g.* Boron, Lithium, magnesium, etc., with which it forms nitrides; some of its compounds with other elements are very active. Thus, combined with hydrogen it forms ammonia gas, which is powerfully alkaline; one of its compounds, with H and O, is nitric acid, HNO_3, one of our most corrosive acids; combined with carbon, it forms a colourless gas, cyanogen, C_2N_2, which is very poisonous, and which with H forms hydrocyanic or prussic acid, HCN.

Nitrogen may be liquefied if the temperature is reduced below $-146°$, its critical temperature. At ordinary pressures its boiling-point is $-193°$.

ARGON (Symbol A, At. w. 39·8).

When nitrogen obtained from the atmosphere is passed over heated magnesium the gas is absorbed with the formation of magnesium nitride, but leaves a residue of about 1·2 per cent. of its volume which remains unabsorbed, and is another element, known as Argon. This element was only discovered in 1895, and it is even more inert than nitrogen, no definite compound having yet (1898) been prepared from it. It can also be obtained by causing the nitrogen to combine with oxygen by means of electric sparks and absorbing the oxides of nitrogen produced. It may be liquefied at −187°, and solidifies below −190°. Its molecule is believed to consist of one atom only; in this respect it differs from the gases we have previously studied.

THE ATMOSPHERE.

The air is a mixture of about 21 volumes oxygen, 78 volumes nitrogen, and 1 volume argon, or by weight about 23·1 parts oxygen, 75·6 parts nitrogen, and 1·3 parts argon. The atmosphere also contains a relatively small quantity of carbonic acid (CO_2), three to four volumes in 10,000, and aqueous vapour, the quantity of which varies greatly, but on an average is about one and a half volumes in 100; probably there are also traces of ammonium nitrate and ozone.

The reasons why we believe air to be a mixture of oxygen and nitrogen, and not a chemical compound of these elements, can hardly be appreciated until we have discussed the characteristics of a chemical compound.

1. A chemical compound has always identically the same composition: thus ordinary salt ($NaCl$) always contains 23 parts of sodium by weight combined with 35·5 parts of chlorine, whether it is obtained from sea-water, or by passing chlorine gas over heated sodium, or by pouring hydrochloric acid on sodium carbonate; as long as it is sodium chloride, its composition is absolutely invariable.

2. The elements in a chemical compound are always present in *simple* multiples of their atomic weights: thus atomic weight of N being 14 and atomic weight of O = 16, chemical compounds of these two elements may contain 14 parts by weight of N to 16 of O—*i.e.*, one atomic weight of N to one atomic weight of O, or 28 of N to 16 of O—*i.e.*, 2 to 1, or 14 of N to 32 of O—*i.e.*, 1 to 2, or 28 of N to 48 of O, 2 to 3, etc.

3. When elements unite to form a chemical compound, we invariably get some obvious physical change produced—*e.g.*, heat is evolved or absorbed, or a change of colour or volume is observed. Thus when hydrogen combines with oxygen, great heat is evolved, and the gases condense to a liquid. When the brilliant white metal mercury unites with the colourless gas oxygen, a red powder is formed, etc.

Now in the case of the atmosphere, none of these characteristics of a chemical compound are present. Thus, if we mix four pints of nitrogen with one pint of oxygen, we observe no change of colour or volume, and no heat is evolved; again the composition of the air, though fairly uniform, is not absolutely constant, slight variations in its composition can be detected, and lastly its elements are not present in simple multiples of their atomic weights. The relative weights of oxygen and nitrogen in the air are 23·11 of O, and 75·86 of N; if we divide these numbers by their respective atomic weights we get

$$\frac{23 \cdot 11}{16} = 1 \cdot 44, \text{ and } \frac{75 \cdot 86}{14} = 5 \cdot 49.$$

Now 1·44 is to 5·49 as 1 to 3·8, or 5 to 19, which is not a simple ratio.

Taking into consideration the fact that the air is not a chemical compound, its composition is marvellously uniform. This uniformity is brought about, *firstly*, by two great chemical reactions: in one oxygen is removed from the air, and replaced by carbonic acid, CO_2, in the other carbonic acid is decomposed, and oxygen liberated; *secondly*, by the almost perfect mixing effected by the mechanical action of the winds and the constantly acting process of diffusion (*see* Vol. III., p. 321).

In all combustions of carbon-containing substances, including respiration, which may be considered as a slow combustion of the food taken into the body, CO_2 is evolved, and O absorbed; so that all animals and fires are removing oxygen from the air, and replacing it by CO_2. On the other hand, the sun, by the agency of the green colouring matter in the leaves (*see* Botany, Vol. II., pp. 270, 377), is as constantly decomposing the CO_2 and replacing it by oxygen. It is true that plants, like animals, absorb a small quantity of oxygen, and convert it into CO_2; but this absorption, which goes on both day and night, is insignificant compared to the vast amount of oxygen evolved during daylight.

The amount of oxygen present in the air can be estimated in two ways. The simplest is to fill a graduated glass tube, closed at one end, with mercury, invert it in a small pneumatic trough containing mercury, and then blow in a little air from a bellows. This quantity of air is carefully measured. A strong solution of pyrogallic acid—so largely used by photographers—is then sucked up into a glass tube drawn out at one end and bent into a hook; some of this solution is now blown out into the graduated tube (*see* Fig. 17), taking care not to blow out all the liquid. The solution immediately rises, and floats on the surface of

the mercury; a small piece of caustic potash (KHO) is then placed under the tube, in which it rises and dissolves the solution of pyrogallic acid, rendering it strongly alkaline. This alkaline solution absorbs oxygen rapidly, turning brown, and in about half an hour all the oxygen in the air will be absorbed, and the mercury will rise to fill its place. When the mercury ceases to rise, the diminution in the volume of the gas, after the necessary corrections for temperature and pressure, gives the quantity of oxygen in the volume of air taken.

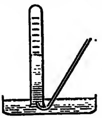
Fig. 17.

Another plan is to explode a measured volume of air with an excess of pure hydrogen, and observe the diminution in volume. A measured volume of air, say 150 cubic centimetres, is introduced into a eudiometer. This is a uniform glass tube, bent into a U-shape; one limb is open, and the other, which is graduated, is closed, and has two platinum wires fused into the top, as explained under Water (Fig. 11, p. 1). Seventy-five cubic centimetres of hydrogen are then added, the open limb closed with the thumb (*see* Fig. 18), and a spark passed through the mixture, when all the oxygen in the air unites with twice its volume of hydrogen to form a minute quantity of water, so that three volumes of gas (2 vols. of H and 1 vol. of O) vanish. If we measure the contraction, one-third of this will obviously be due to oxygen. Thus, to continue our experiment, the 225 c.c. of air and hydrogen will be found after the experiment to measure 130·5 c.c.; the contraction is, therefore, $225 - 130 \cdot 5 = 94 \cdot 5$ c.c. and $\frac{94 \cdot 5}{3} = 31 \cdot 5$ vols. of oxygen in 150 c.c. of air, or 21 vols. of O in 100 vols. of air.

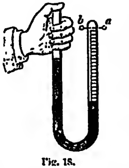

Fig. 18.

That carbonic acid, CO_2, exists in the atmosphere can be proved by exposing some lime water, $Ca(HO)_2$, in a saucer to the air: the surface soon becomes covered with a film of calcium carbonate, owing to the absorption of the CO_2 from the atmosphere—

$$Ca(HO)_2 + CO_2 = CaCO_3 + H_2O$$

In order to measure the quantity of carbonic acid, we must pass a known volume of dry air slowly over a weighed quantity of caustic potash (KHO), and measure the increase of weight—

$$2KHO + CO_2 = \underbrace{K_2CO_3}_{\text{Potassium carbonate.}} + H_2O$$

If a glass of water be cooled by placing ice in it, the invisible aqueous vapour which exists in the air is condensed on the cold surface of the glass, first as a fine mist, and then as visible drops of water. Dew is formed in a similar way; during a clear calm night the earth's surface throws off its heat into space, and becomes colder and colder, until at last the air in contact with it is no longer able to retain its moisture in the state of gas, and it is accordingly deposited as dew on the cold surface of the earth. In order to measure the quantity of water, we pass a known volume of air over a weighed quantity of strong oil of vitriol (H_2SO_4), which absorbs the water, and the increase of weight in the sulphuric acid gives us the weight of the water. The apparatus used for this purpose consists of a large vessel of known capacity, having an aperture at the top and a stop-cock at the bottom, A (Fig. 19), called an aspirator. On turning the tap, water passes out and air is sucked in through the U-tube, B (which is filled with fragments of glass moistened with strong sulphuric acid), to supply its place. The quantity of water in the air can also be estimated by a hygrometer. (*See* Vol. I., p. 209.)

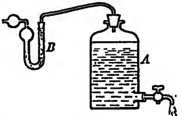

Fig. 19.

OXIDES OF NITROGEN.

Nitrogen combines indirectly with oxygen, forming five compounds—N_2O, NO, N_2O_3, NO_2, N_2O_5.

Protoxide of nitrogen, nitrous oxide, or laughing-gas, N_2O.—This colourless gas is obtained by heating ammonium nitrate (1s. 6d. per lb.), a white crystalline substance. This can be effected in a large test-tube, furnished with cork and delivery-tube, as described under Oxygen (*see* Vol. III., p. 258). The ammonium nitrate melts, and gives off laughing-gas and water—

$$\underbrace{NH_4NO_3}_{\text{Ammonium nitrate.}} = N_2O + 2H_2O$$

it is best to collect the gas over hot water, because it is soluble in its own volume of cold water. It is a colourless gas, with a sweetish taste, which supports combustion almost as vividly as oxygen. It re-ignites a glowing spark, and phosphorus burns in it with great brilliancy. It is distinguished from oxygen by its greater solubility in water, and by the fact that it leaves its own volume of nitrogen when a piece of metallic potassium is heated in it in a bent test-tube (*see* Fig. 20). The potassium is introduced through the mercury by a bent iron

wire. The molecule of N_2O—in accordance with the law given on p. 1—occupies 2 volumes when

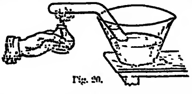

Fig. 20.

it is deprived of its oxygen by the potassium, it liberates a molecule of nitrogen (N_2), which also occupies two volumes. If oxygen be substituted for laughing-gas, the potassium burns until all the gas has disappeared. When laughing-gas is used for inhalation, great care must be taken to secure its purity. Ordinary laughing-gas contains a little peroxide of nitrogen (NO_2), and acid vapours, both of which are highly injurious: the gas should, therefore, be first passed over lime to absorb the acid vapours, and then through a strong solution of ordinary green vitriol (ferrous sulphate, $FeSO_4$) to absorb the NO_2. Nitrous oxide has been liquefied by a pressure of 50 atmospheres at 7° C.

Nitric oxide, NO (formerly written N_2O_2).—This colourless gas is prepared by the action of a mixture of one part of strong nitric acid with two parts of water on copper clippings or turnings. The fragments of copper are introduced into a Woulffe's bottle, which is fitted up as described under Hydrogen (*see* Fig. 5, Vol. III., p. 322). On pouring the nitric acid on to the copper, an effervescence takes place, and apparently a reddish gas is evolved. This colour is due to the air which fills the bottle, and as soon as the nitric oxide has driven out the air, the bottle is seen to be filled with a colourless gas, which can be collected over water as usual—

$$3Cu + 8HNO_3 = \underbrace{3Cu(NO_3)_2}_{\text{Copper nitrate.}} + 2NO + 4H_2O$$

It may be remarked here that, although this equation represents the chief decomposition, yet other actions take place simultaneously, by which N and N_2O are formed. This is also the case with all the equations usually given in text books as representing the reactions of nitric acid on the metals. Nitric oxide is a colourless gas, which does not burn, but supports combustion fairly well. Thus a piece of phosphorus well alight will continue to burn when plunged in this gas; but if the phosphorus is only just alight, it may be extinguished. It is impossible to tell whether it has any smell, because when mixed with air or oxygen it forms immediately a deep red gas, NO_2. Nitric oxide is, therefore, a delicate test for the presence of oxygen. NO is absorbed by a strong solution of ferrous sulphate, and by strong nitric acid. NO can be condensed to a liquid at −11° C. and 104 atmospheres.

Nitrogen trioxide, or nitrous anhydride, N_2O_3.—By the action of nitric acid on white arsenic, As_4O_6, a red gas is produced which was formerly believed to be the compound N_2O_3, the equation being written:—

$$As_4O_6 + 4HNO_3 = 2As_2O_5 + 2H_2O + 2N_2O_3$$

The gas is, however, most probably a mixture of nitric oxide and nitric peroxide. At about −20° it forms a blue liquid, and by the action of water forms an *unstable* acid, *nitrous acid* (HNO_2), which give rise to salts called *nitrites*.

Nitric peroxide or nitrogen tetroxide, NO_2.—This deep red gas can be prepared by heating dry lead nitrate, $Pb(NO_3)_2$ (6d. per lb.) in a test tube.

$$\underset{\text{Lead nitrate.}}{Pb(NO_3)_2} = \underbrace{PbO}_{\text{Litharge or lead oxide.}} + 2NO_2 + O$$

It can also be prepared by the action of nitric acid upon tin or by mixing nitric oxide (NO) with oxygen. It has also been observed in the atmosphere of rooms which have been struck by lightning. It is a deep red gas with an irritating odour, and is very poisonous; it solidifies at −20° C. to a crystalline mass. When heated in a tube the colour of the gas will be observed to darken considerably.

Nitric anhydride, nitrogen pentoxide, N_2O_5.—This crystalline solid can be obtained by passing dry chlorine gas over dry crystals of silver nitrate,

$$\underset{\text{Silver nitrate}}{2AgNO_3} + Cl_2 = N_2O_5 + \underset{\text{Silver chloride.}}{2AgCl} + O$$

or by depriving strong nitric acid of the elements of water by heating it with phosphorus pentoxide, P_2O_5. It is for this reason that this substance is called nitric *anhydride*—i.e., nitric acid *free from water*, because it can be obtained from nitric acid by removing the elements of water

$$2HNO_3 = N_2O_5 + H_2O.$$

When water is added to nitric anhydride, the two substances combine to form nitric acid, much heat being evolved during the combination.

Nitric acid, HNO_3.—This powerfully corrosive acid is usually obtained by heating potassium nitrate (ordinary saltpetre or nitre) or sodium nitrate (Chili saltpetre), with strong sulphuric acid in a glass retort (12 oz. stoppered, 10d.), or on the

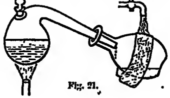

Fig. 21.

manufacturing scale in cast iron cylinders. The nitric acid comes off as a choking vapour, which is condensed in suitable vessels (10 oz. flask, 4d.; *see* Fig. 21).

$$\underbrace{KNO_3}_{\text{Potassium nitrate.}} + H_2SO_4 = \underbrace{HKSO_4}_{\text{Acid potassium sulphate or potassium bisulphate.}} + HNO_3$$

At high temperatures, such as are used in the manufacture of nitric acid, a slightly different reaction occurs, the neutral potassium sulphate K_2SO_4 being formed

$$2KNO_3 + H_2SO_4 = K_2SO_4 + 2HNO_3.$$

Nitric acid, when pure, is a colourless and very corrosive liquid; it is a powerful oxidising agent. When poured on hot charcoal powder the latter is set on fire: it stains the skin, and all bodies containing albumen, yellow. When boiled with sulphur and phosphorus, it converts them respectively into sulphuric and phosphoric acids; it dissolves copper, silver, zinc, and lead easily; it converts tin into a white insoluble powder which, when heated, forms the "putty powder," SnO_2, largely used for polishing spectacle glasses, lenses, etc. (This must not be confounded with ordinary putty, which is whitening—$CaCO_3$—mixed with oil.) Strong nitric acid does not attack gold or platinum; and iron is not attacked by strong nitric acid, but dissolves readily in dilute nitric acid.

Nitric acid is used in large quantities in the manufacture of sulphuric acid, anilin colours, the liquid nitroglycerin (which, when absorbed by a particular form of siliceous earth, forms dynamite), gun-cotton, and for dissolving copper, silver, etc.

The commercial acid often contains traces of sulphuric acid, chlorine, iodic acid, iron, etc.

When nitric acid combines with the oxides of metals, it forms an extensive series of salts, the nitrates, which are all soluble in water.

The nitrates of potassium, sodium, and calcium are frequently found in nature as a result of the oxidation of nitrogenous organic matter, sewage, ammonium salts, etc.

The simplest test for a nitrate is the following:—A small quantity of a cold solution of the substance is placed in a small test-tube, an equal volume of strong sulphuric acid is then added, and the two liquids thoroughly but cautiously mixed: the mixture will be found to be very hot; it is cooled by allowing cold water to flow over the test-tube. When cold a freshly made solution of ferrous sulphate ($FeSO_4$) is gently poured down the side of the test-tube. If the original substance contains any nitrate, a brown ring will be observed at the junction of the two fluids.

HISTORIC SKETCHES, ENGLISH.—XV

[*Continued from p.* 12.]

ENGLAND AND IRELAND.

A GLANCE at the map of the United Kingdom will serve to show that England being inhabited by a powerful people, numerically superior to the peoples both of Scotland and Ireland, those two countries must necessarily be in union with her. Neither of them could rest in security in the neighbourhood of so strong a state; both would in turn be liable to be objected to, as the lamb was by the wolf in the fable; and unless they could secure efficient foreign alliances, they must, sooner or later, fall a prey, as the lamb also did. For it would be manifestly intolerable for the strong state to have possible enemies so near, opening a way at any time into the very heart of her dominion, presenting a ready means of injury available by the first enemy which chose to bid for the friendship of either Scotland or Ireland; and it could not be but that the strong state should perpetually strive to remove, by some means or other, the possibility of harm from such a source. Union would seem therefore to be suggested by the best interests of all concerned. It was also, politically considered, a necessity: a matter in which the time of its coming about was the only doubtful point.

To say that Ireland fell to England by conquest is neither wholly true nor wholly false. It is wholly false to say that it was conquered in the sense that Edward I. tried to conquer Scotland—conquered, that is, as a whole, the entire nation being united under one head for the purpose of resisting one common invader. It is not only doubtful whether, had the Irish been united, the Anglo-Normans who went over would ever have possessed more ground in the country than was needed to cover their bones, but it is almost certain that the subjugation of the island would never have taken place; assuredly it would not by the force which actually went over. Of course, after the precedent set at Hastings, where the fate of England was decided in one pitched battle, and in view of the fact that a mob, however numerous, can avail nothing against the attack of disciplined troops, it is perhaps presumptuous to say so much; but we have only to point to the case of Scotland for justification, and to see how there the whole strength of England failed to hold in bondage a united, freedom-loving people, irregular and undisciplined though they were, in comparison with the followers of the first soldier of his day. Ireland was not conquered as a whole, for it never resisted as a whole—never acknowledged for the

purposes of the common weal one supreme head or "dictator whom all men should obey." It is not, therefore, absolutely true to say that it was conquered, neither is it absolutely false. It fell like the house that was built upon the sand, because it had no foundation and was divided against itself. Bit by bit it was subjugated by force of arms, and according to a system of warfare which aimed at preventing a repetition of resistance by means of extirpation—a system which required the constant presence of a strong military force in the conquered districts, and which provoked from time to time those outbursts of national and party anger which the system has periodically put down with bloodshed and violence. At no one period in her history has Ireland ever been united as Scotland was when she successfully resisted the invader; at no one time has the sister island been animated by the Scottish love of freedom, and dogged determination never to acknowledge a foreign yoke; and certainly, at the time of the first attempt that was made upon her independence, Ireland was split up into rival factions as bitter and hostile to one another as the worst common enemy could desire.

The restless spirit that dwelt in the breast of every Norman very early drove the Norman masters of England to seek fresh adventures, new conquests. Before their power in England was consolidated, before they had had time to push their authority into the heart of Scotland, they looked greedily across the water which divided their newly gotten kingdom from the kingdoms of Ireland, and they resolved to win in them a settlement as absolute and abiding as that they had obtained in England. Lust of power, of acquisition, rather than any far-sighted views of statesmanship, prompted the first invaders of Ireland to undertake their work, and they entered upon it in a spirit wholly in accordance with the motives that actuated them.

The conquest of Ireland came about in this way: —It had been agreed in 1161, after many trials of strength between the several Irish princes, that Murtogh O'Lochlin, King of Ulster, should be recognised as supreme in the island. He was nominally what was then called a suzerain, as distinguished from a sovereign; that is to say, he was feudal lord over his brethren by their own consent —a "first among equals," but not absolute dominator, except in his own kingdom of Ulster. The princes who consented to this arrangement were four in number—the Kings of Munster, Connaught, Leinster, and Meath, each of whom had vassals under them more or less troublesome, who made their sovereignty as permissive a dignity as the four kings made the dignity of Murtogh O'Lochlin. Of course, a throne resting on such explosive materials must have been but an anxious place, not to say unsafe. The broils which had only been temporarily suppressed through the effect of exhaustion in the combatants, broke out again as soon as strength had been renewed, and all was commotion in the kingdom of Erin. Fighting for fighting's sake was sufficient inducement, when all other causes failed, to make the princes take up arms; and the only wonder is how the people subsisted at all in a country which was ravaged all over with fire and sword on an average once a year. Domestic peace within the limits of the lesser kingdoms themselves was a thing unknown; the vassals were too nearly equal for jealousy not to show itself in action; and combined, they were more than a match for their kings. This was proved in the case of Murtogh O'Lochlin himself, who having waged war on one of his vassals in a perfectly barbarous way, having put out his eyes, and slain his most intimate friends in cold blood, roused by his acts so great a resistance on the part of his other subjects, that he was overthrown and killed in a battle, on the issue of which he had staked his fortune.

On his death in 1166, the nominal sovereignty of Erin passed to Roderic O'Connor, King of Connaught, a savage, whose first act, on coming to his father's throne in Connaught, was to put out the eyes of his two brothers, lest they should be troublesome as competitors. He is also famous for having killed with his own hand an enemy whom he had had loaded with chains, and who was defenceless through his fetters at the time the king struck him. Such a man was not likely to have a peaceable time of it, and his reign proved to be such a turmoil and confusion as to tempt the intervention of a foreign foe.

Dermot Mac-Murchad, King of Leinster, a bloodthirsty and licentious barbarian, had, during the reign of the late suzerain, conducted himself so infamously as to excite universal hatred and disgust against him, except on the part of the suzerains who were his dear friends and intimates. He had carried on an adulterous intercourse with the wife of a neighbouring and friendly prince, Tiernan O'Ruarc, the Lord of Breffny, in Connaught, an act which caused the direst commotion, and was the beginning of sorrows for all Ireland; for it became as fruitful a source of quarrel as the abduction of Helen from her husband Menelaus, and was the root of bitterness which sprang up and finally choked Irish independence. So long as O'Lochlin was on the throne this bad man had a friend, and gloried in his shame shamelessly; but with Roderic O'Connor, though he was what he was, came a very different ruler. O'Connor was

friendly to the lord of Breffny, and espoused his cause immediately on coming to the throne. Under his auspices a rebellion was fomented in Dermot's own kingdom of Leinster. Tiernan O'Ruarc took the field with a large force raised in his own dominions, and recruited by numerous bands of men whom Dermot's brutality and tyranny had embittered against him. In a short time Dermot was driven to his last covert, and was then obliged to fly for succour to the King of England.

Now, at the time he did so, Henry II. was in Normandy, wholly absorbed in his great struggle between Church and State, represented by Thomas à Becket and himself; and it is reasonable to suppose that he did not at the moment care very much for the visitor who came to him with such importunate requests for help in a matter where the King of England's interests were not concerned. The application of the Irish prince, however, was not to be rejected summarily; the sound of it recalled to the mind of the great statesman, who then sat on the English throne a plan he had long ago thought over, but, for want of opportunity, had laid aside. Eleven years before—that is to say, in 1155— he had obtained from Pope Adrian IV. (the only Englishman who ever sat in the chair of St. Peter) a papal bull, granting him the lordship of Ireland with full possession of the country, the Pope claiming, and Henry for the nonce admitting, a right in the Pope to dispose of the whole of Christendom as lord paramount. At the time of the grant it had not suited Henry to take the matter in hand; he had other irons in the fire, and even now it was highly inconvenient to have to stir hurriedly in it. Still a wandering Irish prince driven from his home, and ready to agree to any conditions so long as he was restored and his enemies were punished, was not a sight that presented itself every day; and the astute mind of Henry saw at once the advisability of securing a pretext for his interference, which he would do under guise of helping a neighbouring potentate to his own. Once in Ireland—if with a decent excuse all the better—his plan was never to loosen his hold on it; to make it his either by playing off one petty prince against another, and making the winner recognise him for lord, or else, if needs must, though he did not want the trouble, by regular conquest of the island.

Unable to quit Aquitaine, where Dermot found him, and where certain disputes with the barons, together with the trouble respecting Becket, detained him, Henry gave the Irish prince letters recommendatory to the English nobles, and issued this proclamation in his behalf:—"Henry, King of England, Duke of Normandy and Aquitaine, and Earl of Anjou, to all his liegemen—English, Norman, Welsh, and Scotch—and to all the nations under his dominion, sends greeting. As soon as the present letters shall come to your hands, know that Dermot Prince of Leinster has been received into the bosom of our grace and benevolence. Wherefore whosoever, within the ample extent of our territories, shall be willing to lend aid towards the restoration of this prince, as our faithful and liege subject, let such person know that we do hereby grant to him, for such purpose, our licence and favour."

Armed with this proclamation, Dermot came over to England and hastened to Bristol, where he expected to find those who would lend a willing hand to his enterprise, thus backed by the king; but few of the English nobles had ever heard of him until the present moment, and fewer still were inclined to risk anything in a cause where the question was between barbarism on both sides, and where the issue seemed to promise little profit to assistants. No one who had anything to lose, or who had anything better with which to occupy himself, would listen to the Irish prince, who was driven, therefore, to apply to men of desperate fortunes; and such men there were then as now, and as there always will be, ready for anything which holds out the slightest hope of mending their broken condition. Such a man was Richard de Clare, Earl of Pembroke, commonly known in history as Strongbow. Dermot promised to give him his daughter Eva in marriage, and to secure him the succession, after himself, to the throne of Leinster, on condition of his bringing over an efficient force to Ireland in the following spring. Strongbow assented, and Dermot was fortunate enough to secure, in anticipation of his coming, the service of Maurice Fitz-Gerald and Robert Fitz-Stephen, brothers, and adventurers by birth and profession. These agreed to come over as early in the spring as they could; and Dermot having made his preparations, went secretly to Ireland, and remained concealed there.

A foolish outburst of his, made before his allies could join him, nearly proved to be his ruin, and brought his old enemies, Tiernan O'Ruarc and Roderic O'Connor, titular monarch of Erin, down upon him. He lay at their mercy, which he experienced on condition of renouncing for ever his rights in Leinster, except to a small territory not more than sufficient to support the dignity of a lesser baron. He accepted the condition, purposing only to gain time till his English friends should be ready to join him.

In May, 1169, Robert Fitz-Stephen, accompanied by Hervey de Montemarisco, a relative of the Earl

of Pembroke, and by 30 knights, 60 men-at-arms, and 300 archers, landed in the creek Bann, near Wexford, and were the first Anglo-Normans that had appeared in Ireland as invaders. They were immediately joined by Maurice de Prendergast, a Welsh knight, with 10 men-at-arms and 60 archers. Dermot, with 500 men, all he could collect, hastened to meet them, and the united forces, numbering not more than a thousand men, instantly marched upon Wexford, which capitulated after making a fair show of resistance. From Wexford, Dermot took his friends to Ferns, where they rested three weeks, the Irish princes taking no steps to molest them, or to delay their progress; and from Ferns they went on a marauding expedition into Ossory, to allow of Dermot revenging himself on Mac-Gilla-Patrick, prince of the district, who had caused the eyes of Dermot's son to be rooted out. Ossory was ravaged with fire and sword, the bravest exertions of the people being of no avail against disciplined and armour-clad troops.

Marriage of Strongbow and Eva.

At Tara, Roderic O'Connor convened a council of all the Irish princes, and marched thence with a large but tumultuous army to Dublin. At Dublin divisions sprang up among the chiefs, some of the most powerful of whom withdrew themselves from the league and went home.

Dermot entrenched himself at Ferns, being assisted by the skill and science of his Anglo-Norman allies; and when Roderick came with forces outnumbering the strangers by about thirty to one, he found himself unable to act on the offensive against them. He tried negotiation with Dermot and with the English commanders separately, endeavouring to detach them from each other by appeals to their respective interests. But the confederates compared notes, and the treachery of Roderic returned edgeways into his own bosom. He was compelled, in spite of his great army, to make terms with the rebel, to promise him recognition as sovereign prince of Leinster, and to do the like by his heirs afterwards. Dermot was left free to follow his own inclinations, and he marched with his allies, reinforced by Maurice Fitz-Gerald and a small following, to Dublin, which had thrown off its duty to him, and which was now made to pay for its temerity, being only saved from utter destruction by the wish of Dermot to turn his arms northward, where the King of Munster was fighting on unequal terms with O'Connor of Connaught.

Allying himself with the King of Munster, Dermot drove Roderic back into his own dominions, and finding himself so strong, resolved to set up a claim to be sovereign of all Erin. At this juncture Raymond Le Gros, in command of the vanguard of the Earl of Pembroke, arrived at a place near Waterford, and being joined by Hervey de Montemarisco, succeeded in establishing himself in a fort near Waterford. Three months afterwards the Earl of Pembroke himself, in spite of a positive order from his king—which reached him at Milford Haven as he was about to embark, and which forbade him to proceed—came over to Waterford with 200 knights and 1,000 archers.

Raymond Le Gros joined his master and the earl, knowing that if he wanted to justify by success his disregard of King Henry's orders he must lose no time in setting to work, gave orders for an immediate attack on Waterford. The city was carried by assault, and then Dermot came and gave the earl his daughter Eva in marriage then and there.

It were long to trace out step by step the history of the English campaigns in Ireland, before Henry II. himself came over and assumed the lordship of the country; to show how St. Laurence O'Toole, Archbishop of Dublin, rallied for a time the numerous Irish princes round the national standard, and how his exertions were nearly rewarded with the destruction of all the invaders; how the English adventurers suffered many things at the hands of the Irish, and how they saved themselves by the exhibition of a desperate and splendid courage. It is sufficient for the present purpose to say that Strongbow, having in the summer of 1171 gone over to England, and made his peace with Henry at the price of surrendering to him all sovereign rights and all the ports and fortresses in Ireland, returned with his monarch, who, being now free from the disquietude which had before troubled him, gave his whole attention to achieving the conquest of Ireland. On St. Luke's Day, the 18th October, 1171, Henry landed at the Crook, near Waterford, with 500 knights and 4,000 men-at-arms. Some show of resistance was made in one or two places, but it was feeble and useless against the numbers and discipline of the English troops. Prince after prince gave in his adhesion, swore fealty to Henry, and was admitted his liegeman, so that the English monarch's progress was one of continued triumph; and when, on Christmas Day, he kept his court in Dublin, his table was filled with Irish chieftains who had hitherto maintained a perfectly real independence, only doubtingly confessing the superiority of the titular Irish king.

There can be little doubt that, if Henry had had time to consolidate the power he had acquired in Ireland, he would have settled [illegible] on the island with very little trouble; but unfortunately, perhaps, for Ireland, he was suddenly recalled in the spring of 1172, on account of the proceedings taken against him for his alleged part in the death of Thomas à Becket. On the 17th April, 1172, he sailed from Waterford, after having arranged for the government of his new kingdom, and having appointed various noblemen of his army to posts of command. The laws of England were also imposed on the realm of Ireland.

Never before, and perhaps never since, had Ireland enjoyed a quieter and more contented time than during the six months after Henry's departure. The strength of the English kept the Irish from interfering with them, and their far-reaching power even restrained the Irish from internecine war. The land breathed again, and all went well till the restless spirit of the Irish, not enduring the presence of strangers, broke out again in armed resistance. The fortune of war gave the advantage now to this side, now to that, and at one time it seemed as if the work of conquest in Ireland would have to be done all over again; but in the end the root which had been planted spread abundantly, and by a treaty made between Henry and Roderic O'Connor, it was agreed that the latter should be king over all Ireland, except about one-third, which was given to the English (it was afterwards called the Pale), and that he should do homage for the same, receiving in return the homage of all the lesser Irish princes. An arrangement of this sort was fruitful in disturbances; the English encroached upon the Irish, the Irish ever sought to oust the English, and bloodshed, rapine, and misery were made part of the natural order of things. The only way, at length, in which the island could be governed, if held by the English at all, was by means of a military governor, armed with large discretionary power; and this system of government was adopted from the time of Strongbow till quite modern times, the idea of the ruling powers being, not to do what was best for the interests of the governed, but to secure the conquest which had been made.

Government conducted on this principle, or rather on this want of principle, could have but one result—discontent with, and hatred for, the dominant power. Whenever an opportunity presented itself, whenever the oppression of the government, or the yet more insufferable insolence of the foreign settlers, became too unbearable, rebellions broke forth; and though they did not succeed in breaking the yoke from off the necks of the rebels, they involved the country in such confusion as to make it a thorn and a trouble in the side of England, and

of Pembroke, and by 30 knights, 60 men-at-arms, and 300 archers, landed in the creek Bann, near Wexford, and were the first Anglo-Normans that had appeared in Ireland as invaders. They were immediately joined by Maurice de Prendergast, a Welsh knight, with 10 men-at-arms and 60 archers. Dermot, with 500 men, all he could collect, hastened to meet them, and the united forces, numbering not more than a thousand men, instantly marched upon Wexford, which capitulated after making a fair show of resistance. From Wexford, Dermot took his friends to Ferns, where they rested three weeks, the Irish princes taking no steps to molest them, or to delay their progress; and from Ferns they went on a marauding expedition into Ossory, to allow of Dermot revenging himself on Mac-Gilla-Patrick, prince of the district, who had caused the eyes of Dermot's son to be rooted out. Ossory was ravaged with fire and sword, the bravest exertions of the people being of no avail against disciplined and armour-clad troops.

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LATIN.—XX.

[*Continued from p. 45.*]

LATIN PROSE (*continued*).

WE have said that Latin is more exact than English. This will be especially seen in the following examples:—

(*a*) The greater *precision* of Latin is clearly seen in its stricter use of the tenses—*e.g.*, English constantly uses the present or perfect when the reference is to future time, as in the following instances:—

I hope *to come* to-morrow.
Spero *me venturum esse* cras.
I will do it, if *I can*.
Faciam si *potero*.
When *I have taken* the city I shall return.
Ubi urbem *cepero* redibo.
I have long *missed* you.
Jamdudum te *desidero*.
It *would have been* better to *have spared* the conquered.
Melius *fuit* victis *parcere*.

Latin could not tolerate such carelessness, but always uses the tense proper to the time of the action described. The same lack of precision is seen in such English usages as:—"The time was *now* drawing near (in descriptions)"—Latin *tum;* "You *say* (in a letter)"—Lat. *scribis;* "To *hear* from anyone"—Lat. *Litteras accipere ab aliquo.*

(*b*) The preference of Latin for *personal* and *concrete* constructions is seen in its use of *adjectives* (qualifying the subject) *rather than adverbs* (qualifying the verb), such as *primus, solus, libens, laetus, invitus. primus, prudens, imprudens*, etc.: *e.g.*—

He was the first to do this.
Primus hoc fecit.
He did it against his will
Invitus id fecit.

And in other cases, where English would use a substantival expression: *e.g.*—

He was condemned in his absence.
Absens condemnatus est.
The top of the mountain.
Summus mons.

(So *imus, medius, extremus*, etc., and a few nouns such as *senex, adolescens, puer, consul*, etc.)

Where there is a personal subject, the personal construction is usually found. Compare the English "It seems that I said that in vain," with the Latin "Videor id frustra dixisse;" and "It is said that Cæsar was the most compassionate of men," with "Dicitur Caesar ante omnes misericors fuisse." In such cases the impersonal construction, "*videtur* me dixisse," "*dicitur* Caesarem fuisse," is infrequent. The nearest approach to it found in Latin is the equivalent of our "*they say* that . . "—viz., *dicunt, ferunt, tradunt*—followed by accusative and infinitive.

In the same way, the preference of Latin for the *active* voice rather than the passive is strongly marked, prominence being thus given to the agent, and greater vividness and simplicity secured.

So where we use abstract nouns, etc., Latin adopts a more personal phrase: *e.g.*—"The death of Hector," "Hector *ademptus;*" "the loss of Sardinia," "Sardinia *amissa;*" "I hate ingratitude," "*immemorem* beneficii odi;" "everyone admires poetry," "*poetas* nemo non miratur." So "by a unanimous verdict" is "*omnium* judicio;" "happiness" is "beata vita," and so on.

(*c*) The *emphatic* or *rhetorical* character of Latin shows itself in the order of the words; in the pointing of the sentence by the use of demonstrative pronouns and such words as *ita, adeo, tum, quidem, autem, vero*, which fix the attention, and arouse it to watch for the coming explanation, result, or statement, of whatever kind it may be; and in such usages as that of the superlative, to express merely a high degree—*e.g.*, "a brave man" is "vir *fortissimus*," and a similar kind of exaggeration, as we should call it, tinges almost all Latin.

The following exercise contains a number of instances of these differences between the Latin and English languages, and will give the student an opportunity of applying all that has hitherto been said. Let him, above all, first think the English into its simplest, most personal and concrete form, and then translate it into Latin—

He threatened to kill him on the top of the mountain. We have long been desiring to hear from you. It is said that the capture of the island caused him much grief. I go back home to-morrow. The city at this time was strengthened by three walls. It seemed that he did it unwittingly. Everyone hates open flattery. I shall say it gladly, if you are the only one to object. It would have been much easier to have secured happiness for him in his boyhood. During my consulship I willingly risked my life for my country.* It is unanimously acknowledged that I was a brave man. But the whole country* has shown me the utmost ingratitude. I shall seek another country,* where courage and patriotism are still admired. When I am no longer present, they will miss me; but when I have experienced the gratitude of friends, I shall not again betake myself into the midst of envy and malevolence. They say that since the death of Cicero there has been no real oratory in the world.

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§ 9. By a COMPOUND *sentence* is meant a sentence

* Note carefully the different senses in which this word is used.

English governors and statesmen, it is to be feared, looked rather to the plucking out of the thorn than to remedying the causes which led to that thorn being pricked into her. Here are words written by Edmund Spenser the poet, in Elizabeth's time, in his "Views of the State of Ireland," words which, from their vigour and aptness, might have been written at a much later date:—"There have bin divers good plottes devised, and wise councels cast already about reformation of that realme; but they say it is the fatall destiny of that land, that no purposes whatsoever which are meant for her good wil prosper or take good effect, which, whether it proceed from the very genius of the soyle, or influence of the starres, or that Almighty God hath not yet appointed the time of her reformation, or that hee reserveth her in this unquiet state till for some secret scourge, which shall by her come unto England, it is hard to be knoune, but yet much to be feared." And thus Spenser answers his own questions:—"Surely I suppose this but a vaine conceipt of simple men which judge things by their effects and not by their causes: for I would rather thinke the cause of this evill, which hangeth upon that countrey, to proceed rather of the unsoundnes of the councels and plots, which you say have bin oftentimes laid for the reformation, or of faintnes in following and effecting the same, than of any such fatall course appointed of God, as you misdeem; but it is the manner of men, that when they are fallen into any absurdity, or their actions succeede not as they would, they are always readie to impute the blame thereof unto the heavens, so to excuse their oune follies and imperfections."

The "good plots and wise counsels" above referred to were either not appreciated by the Irish, or—and this is closer to the truth—they were devised so much in the selfish interests of the English and so little in the interests of the Irish, that the latter would have none of them, and, as has been said, they rose in rebellion on every favourable occasion. Under Henry III., under Elizabeth, under James I. and Charles I., their uprisings were general and most formidable, requiring the whole strength of England to crush them, though it did not at the same time crush the almost universal discontent. Not till Oliver Cromwell himself took the military command in Ireland could that country ever have been said to be thoroughly subdued; and the manner in which he behaved there, following out to the uttermost the traditionary English policy, is remembered to this day with dread and a shudder, and the Irish peasant can wish no worse curse to fall upon the head of an enemy than the "curse of Crum'll." He marched right through the country, conquering all before him, scarcely forgiving those who did not resist him, slaughtering without mercy all who dared to oppose his arms. Whole garrisons were put to the sword, and Ireland, blinded with the blood of her children, remained for a while at rest, unable to move, pressed down by the iron heel of the mighty warrior. Then came William III., pursuing into Ireland his father-in-law, outcast from England, and the land groaned again under the tramp of armed men and the roar of cannon; but the battle was the battle of English against English, though on Irish ground, and brought no good to the country in which it was fought. The cause of William once triumphant, the old policy of repression was adopted, and religious heats which had already been thrown out to a large extent, and which had severely embittered the relations between Protestants and Roman Catholics, grew fiercer, and rendered the struggle more and more desperate.

Not until after the lamentable rebellion which took place in 1798, and which was assisted by the French, then struggling by any means to inflict mortal injuries upon Great Britain, did English statesmen see the propriety and the wisdom of doing "justice to Ireland." The immediate political result of this rebellion, which was not put down without much bloodshed both on the field and on the scaffold, was the union of Ireland with the sister kingdom, and this act was consummated, under the auspices of Mr. Pitt, on the 1st of January, 1801. Before that date Ireland was a separate kingdom, though acknowledging the same king, had a separate Parliament of two Houses, and was, as far as her own internal affairs went, distinct from Great Britain. But it was found that the Parliament was steeped in corruption to the lips, that selfish interests selfishly advocated were alone represented in it, and that the few brilliant statesmen, properly so called, whose voices from time to time were heard in it, were borne down with the dead weight of those who saw no use in legislating for the real good of the people.

Mr. Pitt therefore determined to bring about a union between the countries. In the face of much opposition, and under circumstances of much public danger, he carried his point, and in January, 1801, the Irish Parliament, by its own consent, ceased to exist. Since that time Irish interests have been represented by members sitting in the imperial House of Commons at Westminster. and the peerage of Ireland by representative peers in the House of Lords. Since that time also Irish interests have been more conscientiously considered than before, and legislation, of which the distinct object was to do justice to Ireland, has gone forward with a quick hand.

See:—Cassell's History of England.

(4) The imagined or supposed circumstances (Conditional): *e.g.*—

> I shall come to-morrow *if I can.*
> *Si potero*, cras veniam.

(5) The circumstances positively stated, and regarded as contrasted with the principal clause (Concessive): *e.g.*—

> *However unwilling he may be*, I shall try to help him.
> *Quamvis sit invitus*, tamen juvare illum conabor.

(6) The time of the action (Temporal): *e.g.*—

> His father came *when he had done everything.*
> *Cum omnia fecisset*, venit pater.

(7) The circumstances with which something in the principal clause is compared, or by which it is limited (Comparative or Limitative): *e.g.*—

> I wish you to be better *than you are.*
> Te, *quam es*, meliorem esse volo.
> *As you sow*, so will you reap.
> *Ut sementem feceris*, ita metes.
> *Cf.* In hostes, *prout cujusque animus erat*, ruebant.

Not till we have mastered the difference between these various kinds of sentences—simple and compound, principal and subordinate—shall we have secured a solid basis on which to build up a thorough knowledge of the structure of Latin prose. We shall constantly have to refer to this analysis of the sentence.

§ 11. And there is one more point which must be clearly before us—the meaning of the terms *Oratio Recta*, *Oratio Obliqua*, and *Virtually Oblique.*

If we are reporting the statements, questions, or petitions of anyone (ourselves or someone else), we can do it in two ways. Either (1) we can repeat the very words which were used by the speaker or writer, without any alteration, simply prefixing to them or inserting parenthetically after the first convenient pause—or, if the sentence be short, adding at the end of them—the appropriate verb in the person required; or (2) we can take the words, as it were, into our own mouth, and report them at second-hand, in which case the whole reported speech becomes dependent on the verb by which we introduce it.

The first of these methods, as you have already learnt, is called *Oratio Recta* (1); the second, *Oratio Obliqua* (2): *e.g.*—

In § 10 (i.) we have three examples of *Oratio Obliqua;* but the sentences (*vide* § 7) might have been reported in *Oratio Recta* as follows:—

> (*a*) Cicero, inquit, orator fuit.
> (*b*) Rogat: Unde advenisti?
> (*c*) Exclamat: Ab Italia discedat.

But very often a subordinate sentence really contains an allusion to the words or thoughts of another, without any verb of saying or thinking being actually expressed; that is, the statement made in such a sentence is given not as representing the conviction of the speaker or writer, but as representing the conviction of others already alluded to. Such a sentence is said to be *Virtually Oblique: e.g.*—

> They made a sally from the camp, because they had no other hope of safety.

The English here, as so often, is ambiguous. The subordinate clause may express the speaker's own opinion as his opinion; but it may also mean that it was *their* opinion (= because, as they thought or said, there was . .), and in that case it is *Virtually Oblique.* Latin, as we shall see later on, is able to distinguish in expression between the two different thoughts. In both languages we must keep a very careful and constant outlook, in order to espy at once, and translate correctly, instances of this *concealed Oratio Obliqua*, which we shall often find lurking hidden behind an expression that is capable of conveying such a double meaning. Our English use of a past tense to represent *Oratio Obliqua* makes special caution in translation necessary.

TRANSLATION FROM PLINY (*continued*).

Ubi coepit advesperascere, jubet sterni sibi in prima domus parte, poscit pugillares, stilum, lumen: suos omnes in interiora dimittit, ipse ad scribendum animum, oculos, manum intendit, ne vacua mens audita simulacra et inanes sibi metus fingeret. Initio, quale ubique, silentium noctis, deinde concuti ferrum, vincula moveri: ille non tollere oculos, non remittere stilum, sed obfirmare animum: tum crebescere fragor, adventare etiam, et jam ut in limine, jam ut intra limen audiri: respicit, videt, agnoscitque narratam sibi effigiem. Stabat innuebatque digito, similis vocanti: hic contra, ut paullum exspectaret, manu significat, rursusque ceris et stilo incumbit: illa scribentis capiti catenis insonabat: respicit rursus idem, quod prius, innuentem: nec moratus, tollit lumen et sequitur. Ibat illa lento gradu, quasi gravis vinculis; postquam deflexit in aream domus, repente delapsa deserit comitem: desertus herbas et folia concerpta signum loco ponit. Postero die adit magistratus, monet, ut illum locum effodi jubeant. Inveniuntur ossa inserta catenis et implicita, quae corpus aevo terraque putrefactum nuda et exesa reliquerat vinculis: collecta publice sepeliuntur: domus postea rite conditis manibus caruit.

NOTES.

Coepit is pleonastic, as *advesperascere* means "to *begin* to be evening."

Sterni. Passive infinitive; supply *lectum* as the subject to it.

Pugillares (lit. "what can be held in the fist") came to mean

"small writing tablets." These were made of wax (called *cerae*, below), and a pointed piece of iron (*stilus*) was used for writing on them. The letters were engraved in the wax, and when the particular notes were done with, the wax was smoothed out for a fresh impression.

Suos, i.e., *servos*. "The members of his household."

Interiora. The neuter plural of an adjective is often used as a substantive denoting place. "The inner parts (of the house)."

Animum. Lit. "applies his mind, his eyes, his hand to writing," i.e., devotes his whole attention.

Audita. "That he had heard of."

Sibi fingere. "To make for himself" = "to imagine."

Quale ubique, i.e., *est*. *Erat* must be supplied with *silentium*.

Concuti. This and the following verbs are the "historical infinitive." The syntax will tell you that the infinitive is often used instead of a past tense of the indicative.

Offirmare animum. "Confirmed his resolution." *Animus* must be translated variously according to the sense of the passage—"mind, thought, resolution, feeling, temper."

Jam. The repetition of this word presents the scene vividly—"Now as on the threshold, now within the threshold."

Stabat, i.e., the ghost, *effigies* or *imago*, as it is called.

Similis vocanti. Lit. "like to one calling" = "as if he were calling."

Significat and *incumbit* are historic presents. *See* last lesson.

Respicit here is transitive, "looked back at," "looked back and saw." *Idem* (neuter) is governed by *innuentem*, "beckoning (in) the same way."

Illa, *effigies*.

Aream. The open courtyard which was usually placed in the middle of a Greek house.

Dilapsa. "Glided down," i.e., "sunk."

Adit. "Visits."

Effodi. From *effodio*, a verb in *-io* of the 3rd conjugation.

Quae corpus, etc. *Quae*, qualified by *nuda et exesa vinculis*, is the object of *reliquerat*; *corpus . . . putrefactum* is the subject.

Publice. "At the public expense."

Rite conditis manibus. *Manes* (a word only found in the plural) means the ghost or spirit of the dead. *Condere manes* = "lay the spirit to rest." Trans., "The house was freed from (lit. lacked) the spirit duly laid to rest." The Greeks and Romans thought that if a man did not receive a proper burial, he could not rest in his grave. In this case we must suppose that the man had perhaps been murdered and secretly buried without any religious rites, therefore his spirit could not rest until these had been duly performed.

KEY TO TRANSLATION FROM PLINY (p. 41).

There was at Athens a house which was good-sized and roomy, but of bad reputation and deadly. In the silence of the night there was a noise of iron (being moved), and should you listen more attentively, the clank of chains, at first at some distance, then quite close, was heard; soon there appeared a ghost, an old man wasted with want and dirt, with long beard and shaggy hair; on his legs he wore fetters, on his hands chains, which he rattled. *After that*, sleepless nights were passed by those in the house, rendered gloomy and terrible by fear; the sleeplessness was followed by illness, and as their alarm increased, by death. For by day, also, although the apparition had vanished, the memory of it flitted before their eyes, and their prolonged fear proved a cause of (fresh) fear. In consequence the house became deserted, and condemned to solitude, and was entirely given up to that monster; still it was advertised, in case anyone, ignorant of so great a disadvantage, might like either to buy or to hire it. There came to Athens Athenodorus, a philosopher, he read the bill, and, hearing the price, made inquiries, because the cheapness of it caused suspicion, and learnt the whole story; and none the less, in fact all the more keenly, he hired it.

MUSIC.—XX.

[*Continued from p. 16.*]

(TONIC SOL-FA NOTATION.)

TRANSITION.

ALL the first exercises should be pointed on the upright columns, the student meanwhile singing. When this can be done freely the exercises should be sung from the printed copy. The practical point, in the first place, is to find a tone in a side column and to sing the same sound to the syllable on the same level in the other column. Then endeavour to get the following tones from the new point of departure.

FIRST SHARP KEY.	
doh^1	fah
te	me
lah	ray
soh	doh
fe	te_1
fah	
me	lah_1
ray	soh_1
doh	fah_1
	→

FIRST FLAT KEY.	
soh	doh^1
	te
fah	*ta*
me	lah
ray	soh
doh	fah
te_1	me
lah_1	ray
soh_1	doh
←	

First sharp key.

Ex. 169.

$$\begin{matrix}\text{Left col.}\ d\ m \\ \text{Right col.}\end{matrix}\begin{Bmatrix} s\ fe\ s \\ d\ t_1\ d\end{Bmatrix}\begin{matrix} \\ d\ r\ m\ r\end{matrix}\begin{Bmatrix} s\ fe\ s \\ d\ t_1\ d\end{Bmatrix}\begin{matrix} s\ s\ f\ m\ r\ d. \\ \ \end{matrix}$$

Ex. 170.

$$\begin{matrix}\text{L.}\ d\ s\ m\ d \\ \text{R.}\end{matrix}\begin{Bmatrix} r\ m\ fe\ s \\ s_1\ l_1\ t_1\ d\end{Bmatrix}\begin{matrix} \\ d\ t_1\ d\ r\ d\end{matrix}\begin{Bmatrix} r\ m\ fe\ s \\ s_1\ l_1\ t_1\ d\end{Bmatrix}\begin{matrix} s\ f\ r\ d. \\ \ \end{matrix}$$

Ex. 171.

$$\begin{matrix}\text{L.}\ d\ m\ s\ m \\ \text{R.}\end{matrix}\begin{Bmatrix} m\ fe\ s \\ l_1\ t_1\ d\end{Bmatrix}\begin{matrix} \\ r\ d\ t_1\ d\ s_1\end{matrix}\begin{Bmatrix} m\ fe\ s \\ l_1\ t_1\ d\end{Bmatrix}\begin{matrix} l\ s\ f\ t_1\ d. \\ \ \end{matrix}$$

First flat key.

Ex. 172.

$$\begin{matrix}\text{R.}\ d\ m\ s\ d^1 \\ \text{L.}\end{matrix}\begin{Bmatrix} d^1\ ta\ l \\ s\ f\ m\end{Bmatrix}\begin{matrix} \\ m\ r\ d\ m\end{matrix}\begin{Bmatrix} d^1\ ta\ l \\ s\ f\ m\end{Bmatrix}\begin{matrix} l\ t\ d^1. \\ \ \end{matrix}$$

(4) The imagined or supposed circumstances (Conditional): *e.g.*—

> I shall come to-morrow *if I can.*
> *Si potero,* cras veniam.

(5) The circumstances positively stated, and regarded as contrasted with the principal clause (Concessive): *e.g.*—

> *However unwilling he may be,* I shall try to help him.
> *Quamvis sit invitus,* tamen juvare illum conabor.

(6) The time of the action (Temporal): *e.g.*—

> His father came *when he had done everything.*
> *Cum omnia fecisset,* venit pater.

(7) The circumstances with which something in the principal clause is compared, or by which it is limited (Comparative or Limitative): *e.g.*—

> I wish you to be better *than you are.*
> Te, *quam es,* meliorem esse volo.
> *As you sow,* so will you reap.
> *Ut sementem feceris,* ita metes.
> *Cf.* In hostes, *prout cujusque animus erat,* ruebant.

Not till we have mastered the difference between these various kinds of sentences—simple and compound, principal and subordinate—shall we have secured a solid basis on which to build up a thorough knowledge of the structure of Latin prose. We shall constantly have to refer to this analysis of the sentence.

§ 11. And there is one more point which must be clearly before us—the meaning of the terms *Oratio Recta*, *Oratio Obliqua*, and *Virtually Oblique.*

If we are reporting the statements, questions, or petitions of anyone (ourselves or someone else), we can do it in two ways. Either (1) we can repeat the very words which were used by the speaker or writer, without any alteration, simply prefixing to them or inserting parenthetically after the first convenient pause—or, if the sentence be short, adding at the end of them—the appropriate verb in the person required; or (2) we can take the words, as it were, into our own mouth, and report them at second-hand, in which case the whole reported speech becomes dependent on the verb by which we introduce it.

The first of these methods, as you have already learnt, is called *Oratio Recta* (1); the second, *Oratio Obliqua* (2): *e.g.*—

In § 10 (i?) we have three examples of *Oratio Obliqua*; but the sentences (*vide* § 7) might have been reported in *Oratio Recta* as follows:—

> (*a*) Cicero, inquit, orator fuit.
> (*b*) Rogat: Unde advenisti?
> (*c*) Exclamat: Ab Italia discedat.

But very often a subordinate sentence really contains an allusion to the words or thoughts of another, without any verb of saying or thinking being actually expressed; that is, the statement made in such a sentence is given not as representing the conviction of the speaker or writer, but as representing the conviction of others already alluded to. Such a sentence is said to be *Virtually Oblique*: *e.g.*—

> They made a sally from the camp, because they had no other hope of safety.

The English here, as so often, is ambiguous. The subordinate clause may express the speaker's own opinion as his opinion; but it may also mean that it was *their* opinion (= because, as they thought or said, there was . .), and in that case it is *Virtually Oblique.* Latin, as we shall see later on, is able to distinguish in expression between the two different thoughts. In both languages we must keep a very careful and constant outlook, in order to espy at once, and translate correctly, instances of this *concealed Oratio Obliqua*, which we shall often find lurking hidden behind an expression that is capable of conveying such a double meaning. Our English use of a past tense to represent *Oratio Obliqua* makes special caution in translation necessary.

TRANSLATION FROM PLINY (*continued*).

Ubi coepit advesperascere, jubet sterni sibi in prima domus parte, poscit pugillares, stilum, lumen: suos omnes in interiora dimittit, ipse ad scribendum animum, oculos, manum intendit, ne vacua mens audita simulacra et inanes sibi metus fingeret. Initio, quale ubique, silentium noctis, deinde concuti ferrum, vincula moveri: ille non tollere oculos, non remittere stilum, sed obfirmare animum: tum crebescere fragor, adventare etiam, et jam ut in limine, jam ut intra limen audiri: respicit, videt, agnoscitque narratam sibi effigiem. Stabat innuebatque digito, similis vocanti: hic contra, ut paullum exspectaret, manu significat, rursusque ceris et stilo incumbit: illa scribentis capiti catenis insonabat: respicit rursus idem, quod prius, innuentem: nec moratus, tollit lumen et sequitur. Ibat illa lento gradu, quasi gravis vinculis; postquam deflexit in aream domus, repente delapsa deserit comitem: desertus herbas et folia concerpta signum loco ponit. Postero die adit magistratus, monet, ut illum locum effodi jubeant. Inveniuntur ossa inserta catenis et implicita, quae corpus aevo terraque putrefactum nuda et exesa reliquerat vinculis: collecta publice sepeliuntur: domus postea rite conditis manibus caruit.

NOTES.

Coepit is pleonastic, as *advesperascere* means "to *begin* to be evening."

Sterni. Passive infinitive; supply *lectum* as the subject to it.

Pugillares (lit. "what can be held in the fist") came to mean

"small writing tablets." These were made of wax (called *cerae*, below), and a pointed piece of iron (*stilus*) was used for writing on them. The letters were engraved in the wax, and when the particular notes were done with, the wax was smoothed out for a fresh impression.

Suos, *i.e.*, *servos*. "The members of his household."

Interiora. The neuter plural of an adjective is often used as a substantive denoting place. "The inner parts (of the house)."

Animum. Lit. "applies his mind, his eyes, his hand to writing," *i.e.*, devotes his whole attention.

Audita. "That he had heard of."

Sibi fingere. "To make for himself" = "to imagine."

Quale ubique, *i.e.*, *est*. *Erat* must be supplied with *silentium*.

Concuti. This and the following verbs are the "historical infinitive." The syntax will tell you that the infinitive is often used instead of a past tense of the indicative.

Obfirmare animum. "Confirmed his resolution." *Animus* must be translated variously according to the sense of the passage—"mind, thought, resolution, feeling, temper."

Jam. The repetition of this word presents the scene vividly—"Now as on the threshold, now within the threshold."

Stabat, *i.e.*, the ghost, *effigies* or *imago*, as it is called.

Similis vocanti. Lit. "like to one calling" = "as if he were calling."

Significat and *incumbit* are historic presents. *See* last lesson.

Respicit here is transitive, "looked back at," "looked back and saw." *Idem* (neuter) is governed by *innuentem*, "beckoning (in) the same way."

Illa, *effigies*.

Aream. The open courtyard which was usually placed in the middle of a Greek house.

Delapsa. "Glided down," *i.e.*, "sunk."

Adit. "Visits."

Effodi. From *effodio*, a verb in -*io* of the 3rd conjugation.

Quae corpus, etc. *Quae*, qualified by *nuda et exesa vinculis*, is the object of *reliquerat*; *corpus* . . . *putrefactum* is the subject.

Publice. "At the public expense."

Rite conditis manibus. *Manes* (a word only found in the plural) means the ghost or spirit of the dead. *Condere manes* = "lay the spirit to rest." Trans., "The house was freed from (lit. lacked) the spirit duly laid to rest." The Greeks and Romans thought that if a man did not receive a proper burial, he could not rest in his grave. In this case we must suppose that the man had perhaps been murdered and secretly buried without any religious rites, therefore his spirit could not rest until these had been duly performed.

KEY TO TRANSLATION FROM PLINY (p. 44).

There was at Athens a house which was good-sized and roomy, but of bad reputation and deadly. In the silence of the night there was a noise of iron (being moved), and should you listen more attentively, the clank of chains, at first at some distance, then quite close, was heard; soon there appeared a ghost, an old man wasted with want and dirt, with long beard and shaggy hair; on his legs he wore fetters, on his hands chains, which he rattled. After that, sleepless nights were passed by those in the house, rendered gloomy and terrible by fear; the sleeplessness was followed by illness, and as their alarm increased, by death. For by day, also, although the apparition had vanished, the memory of it flitted before their eyes, and their prolonged fear proved a cause of (fresh) fear. In consequence the house became deserted, and condemned to solitude, and was entirely given up to that monster; still it was advertised, in case anyone, ignorant of so great a disadvantage, might like either to buy or to hire it. There came to Athens Athenodorus, a philosopher, he read the bill, and, hearing the price, made inquiries, because the cheapness of it caused suspicion, and learnt the whole story; and none the less, in fact all the more keenly, he hired it.

MUSIC.—XX.

[*Continued from p. 16.*]

(TONIC SOL-FA NOTATION.)

TRANSITION.

ALL the first exercises should be pointed on the upright columns, the student meanwhile singing. When this can be done freely the exercises should be sung from the printed copy. The practical point, in the first place, is to find a tone in a side column and to sing the same sound to the syllable on the same level in the other column. Then endeavour to get the following tones from the new point of departure.

FIRST SHARP KEY.	
doh^1	fah
te	me
lah	ray
soh	doh
fe	te_1
fah	
me	lah_1
ray	soh_1
doh	fah_1
	→

FIRST FLAT KEY.	
soh	doh^1
	te
fah	*ta*
me	lah
ray	soh
doh	fah
te_1	me
lah_1	ray
soh_1	doh
←	

First sharp key.

Ex. 169.

Left col.	d m	s fe s		s fe s	s s f m r d.
Right col.		d t_1 d	d r m r	d t_1 d	

Ex. 170.

L.	d s m d	r m fe s		r m fe s	s f r d.
R.		s_1 l_1 t_1 d	d t_1 d r d	s_1 l_1 t_1 d	

Ex. 171.

L.	d m s m	m fe s		m fe s	l s f t_1 d.
R.		l_1 t_1 d	r d t_1 d s_1	l_1 t_1 d	

First flat key.

Ex. 172.

R.	d m s d^1	d^1 ta l		d^1 ta l	l t d^1.
L.		s f m	m r d m	s f m	

Ex. 173.

R. d s m d^1 {s l ta l} r d r m m {ta l} l t d^1.
L. {r m f m} {f m}

BRIDGE NOTES.

The Tonic Sol-fa notation expresses changes of key in a very clear manner. When once the principle is understood, there can be no doubt as to what the singer is asked to do. But this notational clearness cannot do away with difficulties of the ear. The advantage of the notational simplicity is that the singer has only to think of the musical difficulty, and has not to occupy his thoughts in unravelling notational obscurities.

A change of key is shown by placing the Sol-fa initial of the name to be changed side by side with the initial of the new name. The following are Exercises 169 to 173 rewrittten on this plan.

Ex. 174.

d m ^{s}d t_1 d d r m r d t_1 ^{d}s s s f m r d.

Ex. 175.

d s m d $^{r}s_1$ l_1 t_1 d d t_1 d r d s_1 l_1 t_1 ^{d}s s f r d.

Ex. 176.

d m s $^{m}l_1$ t_1 d r d t_1 d s_1 l_1 t_1 ^{d}s l s f t_1 d.

Ex. 177.

d s m d^1 ^{s}r m f m r d r m m f ^{m}l t d^1.

The exercises that follow should be pointed on the upright columns, and at first it will be found expedient when singing from the printed copy to sing the name and sound of the bridge note, and then to leisurely sing the same sound to its new name. After skill is attained both syllables may be run into one, as "s'doh," "m'lah." "r'soh," etc. Later still, the sound represented by the bridge note should be simply thought, and only the new name uttered.

EXERCISES WITH BRIDGE NOTES.

First sharp key and return.

Ex. 178.—d r m s ^{s}d t_1 d d t_1 l_1 s_1 l_1 t_1 d ^{d}s f m r d.

Ex. 179.—m r d r m $^{m}l_1$ t_1 d r d t_1 d s_1 ^{s_1}r m m f m m r d.

Ex. 180.—s m d r m s l s ^{l}r d d t_1 d s_1 l_1 t_1 d ^{r}l s s f r d.

Ex. 181.—d m r f m r d $^{r}s_1$ l_1 t_1 d r t t_1 d ^{d}s f m l t d^1.

First flat key and return.

Ex. 182.—d s m d^1 ^{d}'s f m r m f r d ^{m}l t d^1 s m d.

Ex. 183.—s m d^1 s ^{f}d r m m f m r m d $^{s}d^1$ d^1 t d^1.

Ex. 184.—m r d m s ^{s}r m r m d m s f m ^{r}s l s l t d^1.

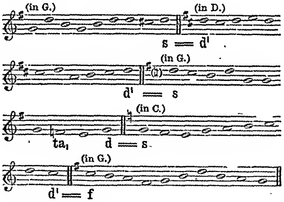
Ex. 185.—s f m d m s d^1 ^{r}'l s s f m r d ^{d}f s l t d^1.

(STAFF NOTATION.)

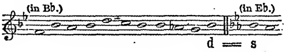
TRANSITION OR MODULATION.

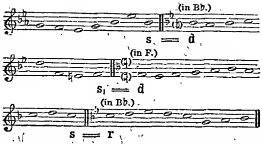
The movement or transition from key to key is often called a MODULATION, although this term is a better one for another kind of change to be described later on. The Staff notationist has two difficulties to face in studying modulations. He has to conquer the musical difficulties with his ear and voice, and he has to decipher the notation. The first exercises given below show the change of key plainly, in order that the student may give all his attention to the musical difficulty. The diagram that follows shows tho changes of Sol-fa name necessary when notes of the same pitch, but of different tonality or key, are compared. The contiguous staves show "one remove" transitions. The student should freqnently practise from this diagram, pointing and singing simultaneously upon the following plan:—Choose any key or stave for a starting-point, sing eight or ten notes (not straight up and down the scale, but skipping backwards and forwards), and then determine upon some point of departure to a note of the same pitch in the stave above or below; sing the "transition" tone, or "bridge," to its new Sol-fa name several times, and then endeavour to sing the *nearest* surroundings in the new key, and when this can be done with certainty, freely leap from tone to tone. Do not arrange the change so as to involve the immediate use of *ta* or *fe* of the new key.

Ex. 194.



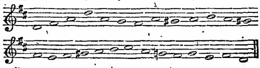
Ex. 195.



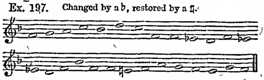


In the above exercises the changes of key are indicated by the changes of signature. But commonly transitions are not so clearly shown. The new flats or sharps—the "distinguishing tones"—are shown by the placing of accidentals before the notes to be altered, and the reader is left to reason out the change as best he can. Sometimes it is very difficult to make out key changes, and therefore to sol-fa correctly, especially in part music, where the new tones of the new key are in some other part than the one being read. Whether to change key at all, and if so where in the passage, and to what key, are matters that can be settled only by practice and experience, guided by a few general rules, to be formulated a little later on. The following hints will serve for the reading of the ensuing exercises. 1st. Regard a sharp fourth as a new *te*, and a flat seventh as a new *fah*. 2nd. Prefer to change on at least one note before the accidental. 3rd. Sing the new Sol-fa name several times before proceeding to the next note.

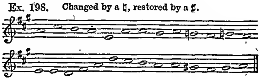
Ex. 196. Changed by a ♯, restored by a ♮.



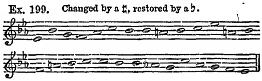
Ex. 197. Changed by a ♭, restored by a ♮.



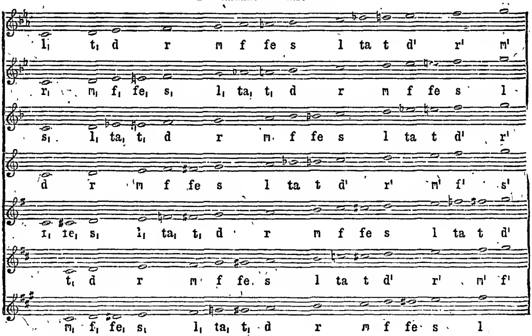
Ex. 198. Changed by a ♮, restored by a ♯.



Ex. 199. Changed by a ♮, restored by a ♭.



TRANSITION DIAGRAM.



several terms to one. Thus, the expression $2a + 7a + 4a$ may be *abridged* by uniting the three terms into one. Thus, $2a$ added to $7a$ makes $9a$, and $4a$ added to $9a$ makes $13a$—that is, $2a + 7a + 4a = 13a$.

There are *two cases* in which *reductions* can be made.

49. *Case* 1.—When the *quantities* are *alike*, and the *signs alike*, as $+4b+5b$, or $-4y-3y$, etc. Find the sum of the *co-efficients, annex the common letter or letters, and prefix the common sign.*

EXAMPLES.—(1) What is the sum of $3a$, $4a$ and $6a$?

Here, $3a + 4a + 6a = 13a$. *Ans.*

(2)	(3)	(4)	(5)
$3xy$	$7b + xy$	$ry + 3abh$	$cdxy + 3mg$
$7xy$	$8b + 3xy$	$3ry + abh$	$2cdxy + mg$
xy	$2b + 2xy$	$6ry + 4abh$	$5cdxy + 7mg$
$2xy$	$6b + 5xy$	$2ry + abh$	$7cdxy + 8mg$
$13xy$	$23b + 11xy$	$12ry + 9abh$	$15cdxy + 19mg$

50. *The mode of proceeding is the same when all the signs are* $-$.

EXAMPLES.—(1) What is the sum of $-3bc$, $-bc$, and $-5bc$?

Here $-3bc - bc - 5bc = -9bc$.

(2)	(3)	(4)
$-ax$	$-2ab - my$	$-3ach - 8bdy$
$-3ax$	$-ab - 3my$	$-ach - bdy$
$-2ax$	$-7ab - 8my$	$-5ach - 7bdy$
$-6ax$	$-10ab - 12my$	$-9ach - 16bdy$

51. *Case* 2.—When the *quantities* are *alike*, but the *signs unlike*—that is, only one of each, as $+9b$ and $-6b$;

Take the less co-efficient from the greater; to the difference annex the common letter or letters, and prefix the sign of the greater co-efficient.

Suppose a man's loss is £500, and his gain £2,000. The algebraic notation is $-500 + 2{,}000$—*i.e.*, £500 is to be *subtracted* from his stock, and £2,000 added to it. But it will be the *same* in effect, and the same expression will be *greatly abridged*, if we add the *difference* between £500 and £2,000, viz., £1,500, to his stock.

EXAMPLES.—(1) What is the sum of $16ab$ and $-7ab$? *Ans.* $9ab$.

To	$+4b$	$5bc$	$2hm$	$dy + 6m$	$3h - dx$
Add	$-6b$	$-7bc$	$-9hm$	$-4dy - m$	$5h + 4dx$
	$-2b$	$-2bc$	$-7hm$	$-3dy + 5m$	$8h + 3dx$

52. If several positive and several negative quantities are to be reduced to one term, first reduce those which are positive, and next those which are negative, to one term, and then proceed as in Art. 51.

EXAMPLES.—(1) Reduce $13b + 6b + b - 4b - 5b - 7b$, to one term.

Here, $13b + 6b + b = 20b$; and $-4b - 5b - 7b = -16b$; Whence $20b - 16b = 4b$. *Ans.*

(2) Add $3xy - xy + 2xy - 7xy + 4xy - 9xy + 7xy - 6xy$.

Here, $3xy + 2xy + 4xy + 7xy = 16xy$;

And, $-xy - 7xy - 9xy - 6xy = -23xy$;

Whence, $16xy - 23xy = -7xy$. *Ans.*

(3) Add $3ad - 6ad + ad + 7ad - 2ad + 9ad - 8ad - 4ad$.

Here, $3ad + ad + 7ad + 9ad = 20ad$;

And, $-6ad - 2ad - 8ad - 4ad = 20ad$;

Whence $20ad - 20ad = 0$. *Ans.*

(4) Add $2abm - abm + 7abm - 3abm + 7abm$.

Here, $2abm + 7abm + 7abm = 16abm$;

And, $-abm - 3abm = -4abm$;

Whence, $16abm - 4abm = 12abm$. *Ans.*

53. If *two equal* quantities have *contrary signs*, they destroy each other: that is, the result of their addition is 0, and they may be cancelled. Thus $+6b - 6b = 0$. And $(3 \times 6) - 18 = 0$.

54. *If the letters, or quantities in the several terms to be added, are* UNLIKE, *they can only be placed after each other, with their proper signs.*

EXAMPLES.—(1) If $4b$, $-6y$, $3x$, $17h$, $-5d$, and 6, be added, their sum will be $4b - 6y + 3x + 17h - 5d + 6$.

(2) Add aa, aaa, to xx, xxx, and $xxxx$.

Different letters, and different powers of the same letter, can no more be united in the same term, than pounds and guineas can be added, so as to make a single sum. Six guineas and four pounds are neither ten guineas nor ten pounds; therefore the sum of the above $= aa + aaa + xx + xxx + xxxx$.

55. From the foregoing principles we derive the following

GENERAL RULE FOR ADDITION.

Write down the quantities to be added without altering their signs, placing those that are alike under each other; and unite such terms as are similar.

Otherwise.—*Write the quantities to be added one after another, putting the sign* $+$ *between them, and then simplify the expression by incorporating like quantities.*

Note 1.—If any of the quantities be in brackets and the sign $+$ be before the brackets, the brackets may be removed without altering the result.

By brackets is meant the vinculum or parenthesis, already explained [Art. 21]. This is one of the most important things in the study of Algebra; its use is unlimited. If quantities be included in any manner between brackets or parentheses, they must be treated as a single quantity—that is, the *result* of the operation of the *signs* within the

Ex. 188.—*Lah* is B, *doh* is D. *Se* is to *lah* what *te* is to *doh*.

|l :— |t :d^1 |t :— |l :— |l :— |se :— }
|l :— |— :— |t :— |d^1 :l |l :— |se :l }
|d^1 :— |t :— |l :— |— :— ||

Ex. 189.—*Lah* is F, *doh* is A♭.

|l_1 :— |t_1 :d |m :— |r :— |d :— |r :m }
|f :— |m :— |r :— |m :f |m :— |d :l_1 }
|f :— |m :— |l_1 :— |— :— ||

It is difficult to sing s soon after se has occurred.

Ex. 190.—*Lah* is E, *doh* is G.

|d :— |m :— |s :— |— :— |m :r |d :m }
|l :— |se :— |l :— |— :— |s :f |m :r }
|m :l |se :l |s :f |m :m |l :— |— :— ||

An idea of *ba* can be got by imagining m ba se l to be s l t d^1 of another key. It is difficult to sing *fah* or *doh* soon after *ba*, and difficult to sing *ba* soon after *fah* or *doh*.

Exercises on Ba.

Ex. 191.—*Lah* is C, *doh* is E♭.

|l_1 :— |d :r |m :— |m :— |ba :— |se :— }
|l :— |— :— |l_1 :— |d :m |l :— |r :f }
|m :m |ba :se |l :— |— :— ||

Ex. 192.—*Lah* is D, *doh* is F.

|m :r |d :t_1 |l_1 :d |m :— |f :— |d :r }
|m :— |— :— |m :— |ba :se |l :m |f :— }
|m :r |d :t_1 |l_1 :— |— :— ||

Ex. 193.—*Lah* is C♯, *doh* is E.

|m :d |r :m |ba :se |l :— |l :m |d :m }
|ba :se |l :— ||

COMMON LEAPS IN THE MINOR KEY.

Ex. 194.—*Lah* is B, *doh* is D.

|m .r :d .t_1 |l_1 :l |f .m :r .f |m :— }
|se :l |f .m :r .d |t_1 :f |m :— }
|d^1 :se |t :l |r .m :f .s |f :m }
|t :m |d^1.t :l .se |t .l :l .se |l :— ||

Fah to *se* and *se* to *fah*.

Ex. 195.—*Lah* is C, *doh* is E♭.

|l_1 :d |m :l |se :l |f :m |f :se |l :d^1 }
|t :t |l :— |m :f |m :l |f :f |m :m }
|l :se |f :m |ba :se |l :— ||

ALGEBRA.—II.

[*Continued from p.* 27.]

ADDITION.

EXAMPLES.—(1) John has x marbles and gains b marbles more. How many marbles has he in all?

In this example we wish to add x marbles to b marbles. But addition in algebra is denoted by the sign $+$. Hence $x + b$ is the answer—*i.e.*, John has the sum of x marbles added to b marbles.

(2) What is the sum of $3b$ pounds added to the sum of c pounds and f pounds?

By algebraic notation, $3b + c + f$ pounds is the answer.

44. The learner may be curious to know *how many* marbles there are in $x + b$ marbles; and *how many* pounds in $3b + c + f$ pounds. This depends upon the *number each letter stands for*. But the questions do not decide what this number is. It is not the *object*, in adding them, to ascertain the *specific* value of x and b, or $3b$, c, and f; but we find an algebraic expression, which will *represent* their *sum* or *amount*. This process is called *addition*. Hence

45. ADDITION in algebra may be defined as *the connecting of several quantities with their signs into one expression.*

46. *Quantities may be added by writing them one after another, without altering their signs.*

N.B.—*A quantity* to *which* no *sign* is *prefixed* is always to be considered *positive*, that is, the sign $+$ is understood [Art. 12].

EXAMPLE.—What is the sum of $a + m$, $b - 8$, and $2h - 3m + d$? $a + m + b - 8 + 2h - 3m + d$. *Ans.*

47. It is immaterial in what *order* the terms or letters are arranged. If you add 6 and 3 and 9, the amount is the same, whether you put the 6, the 3, or the 9 first—namely, 18. But it is frequently *more convenient*, and therefore *customary*, to arrange the letters in alphabetical order.

48. It often happens that the *expression* denoting the *sum* or *amount* may be *simplified* by reducing

UNLIKE, *write the terms of the subtrahend after those of the minuend* (Art. 51).

Otherwise.—Put the quantity to be subtracted in brackets, and write it after the quantity from which it is to be subtracted, with the sign — between them: then apply the Rules of Addition.

EXAMPLES.

(1) From $6a + 9b$, take $3a + 4b$.

Here, change the signs of the subtrahend, but not those of the minuend, thus:—

$6a + 9b - 3a - 4b$. Next reduce these terms, by Art. 52, and you have the answer, $3a + 5b$.

	(2)	(3)	(4)	(5)	(6)
From	$16b$	$14da$	-28	$-16b$	$-14da$
Take	$12b$	$6da$	-16	$-12b$	$-6da$
Answer.	$4b$	$8da$	-12	$-4b$	$-8da$

(7)	(8)	(9)	(10)	(11)	(12)
$16b$	$12b$	$6da$	-16	$-12b$	$-6da$
$28b$	$16b$	$14da$	-28	$-16b$	$-14da$
$-12b$	$-4b$	$-8da$	$+12$	$+4b$	$+8da$

(13)	(14)	(15)	(16)	(17)
$+16b$	$+14da$	-28	$-16b$	$-16da$
$-12b$	$-6da$	$+16$	$+12b$	$+6da$
$+28b$	$+20da$	-44	$-28b$	$-20da$

(18) From $8ab$, take $6xy$. *Ans.* $8ab - 6xy$.

	(19)	(20)
From	$6aay$	$16aaxx$
Take	$17ay$	$20ax$
Answer.	$6aay - 17ay$	$16aaxx - 20ax$

(21) $6dd + 3d - 4ddd$
$10dc + 2dddd + 4dy$
$6dd + 3d - 4ddd - 10dc - 2dddd - 4dy$

61. From these examples it will be seen that the *difference* between a positive and a negative quantity may be *greater* than either of the two quantities. In a thermometer, the difference between 28 degrees above zero and 16 degrees below is 44 degrees. The difference between gaining 1,000 pounds in trade and losing 500 pounds is equivalent to 1,500 pounds.

62. *Proof.*—Subtraction may be *proved*, as in arithmetic, by adding the remainder to the subtrahend. The sum ought to be equal to the minuend, upon the obvious principle that the difference of two quantities added to one of them is equal to the other.

EXAMPLES.—(1) From $2xy - 1$, subtract $-xy + 7$.

Operation.		*Proof.*	
Here, Minuend	$2xy - 1$	Add $-xy + 7$	Subtrahend.
Subtracted	$-xy + 7$	To $3xy - 8$	Remainder.
Remainder	$3xy - 8$	$2xy - 1$	Minuend.

	(2)	(3)	(4)
From	$h + 3bx$	$hy - ah$	$nd - 7by$
Take	$3h - 9bx$	$5hy - 6ah$	$5nd - by$
Answer	$-2h + 12bx$	$-4hy + 5ah$	$-4nd - 6by$

63. When there are several *terms alike* in the subtrahend, they may be united and their sum be used. Thus,

EXAMPLES.—(1) From ab, subtract $3am + am + 7am + 2am + 6am$.

Here $ab - 3am - am - 7am - 2am - 6am = ab - 19am$ *Answer.*

(2) From y subtract $a + a + a + a$. *Answer.* $y - 4a$

(3) From $ax - bc + 3ax + 7bc$, subtract $4bc - 2ax + bc + 4ax$. *Answer.* $2ax + bc$

(4) From $ad + 3dc - bx$, subtract $3ad + 7bx - dc + ad$. *Answer.* $4dc - 8bx - 3ad$.

64. The sign —, placed before the marks of *parenthesis* which include a number of quantities, requires that, when these marks are removed, the signs of *all* the quantities thus included should be changed. Thus $a - (b - c + d)$ signifies that the quantities $b - c$ and $+ d$ are to be subtracted from a. Remove the *parenthesis*, and the expression will then become $a - b + c - d$, an expression which has exactly the same meaning as the former.

EXAMPLE.—From $xy + d$, take $7ad - xy + d + hm$. Here $xy + d - (7ad - xy + d + hm) = -7ad + 2xy - hm$. *Answer.*

65. On the other hand, when a number of quantities are to be introduced within the marks of parenthesis, with — immediately preceding it, their signs must be changed. Thus, $-m + b - dx + 3h = -(m - b + dx - 3h)$.

EXERCISE 5.

1. From $6ab + 7xy + 18dfg$, take $3xy + 4ab + 8dfg$.
2. From $-35ax - 21ab - 37m$, take $-30m - 15ab - 10ax$.
3. From $9ay + 10bx + 22bc$, take $12ay + 31bc + 50bx$.
4. From $8xy - 10ab + 6d$, take $-12ab + 10d + 24xy$.
5. From $7a + 6x + df + xyz$, take $3x - 4a - 3df - 11xyz$.
6. From $18bc - xy + 22gh$, take $41xy - gh + bc$.
7. From $21ax + y + ac - ay$, take $4a - bx + x - yz - dc$.
8. From $21x + 40xy - 13n$, take $42 + 10ab - 5bc$.
9. From $5xy$, take $2ab + 30ab + ab - 4ab$.
10. From $5ax + 10ay$, take $4ax - ay + 3ax + 4ay$.
11. From $a + b$, take $-(c + d - f + g - h - xy)$.
12. From $7ab + 10xy - 7ad$, take $-(6ab - 12xy + ad)$.
13. Introduce the following quantities within a parenthesis with — immediately preceding, without altering their value; viz., $-a + b - c - d + f + gh$.

KEY TO EXERCISES.

EXERCISE 1.

1. $(a - h) \times (b + c + d) = 37m + \frac{b}{h + b}$. 2. $a + b : \frac{h}{c} :: ac : 12h$.

3. $\frac{a + b + c}{6abc} = 4(a + b + c) - d$. 4. $\frac{6}{a + b} = 7d - \frac{b}{3x}$.

Exercise 2.

1. The product of a and b increased by the quotient of 3 times h minus c, divided by the sum of x and y, is equal to the product of d by a increased by the sum of b and c, and diminished by the quotient of h divided by the sum of 6 and h.

2. If a be added to 7 times the sum of h and x, and from this sum the quotient of c less 6 times d, divided by the sum of twice a and 4, be subtracted, the remainder will be equal to the sum of a and h, multiplied by the difference of b and c.

3. The difference of a and b is to the product of a and c as the difference of d and 4, divided by m, is to 3 multiplied by the sum of h, d, and p.

4. If the quotient of the difference between a and h, divided by the sum of 3, and b less c, be added to the quotient of the sum of d and the product of a and b, divided by twice x, the whole will be equal to the quotient of b times a multiplied by the sum of d and h, divided by a times m, lessened by the quotient of c times d divided by h increased by d times m.

Exercise 3.

1. $\frac{3\times6}{2}+3+8\times10=9+3+80=92$.

2. $\frac{24+60}{2\times6}+\frac{(4\times2)+10}{3\times6}=\frac{84}{12}+\frac{18}{18}=7+1=8$.

3. $\frac{4+(3\times6)}{2}+(4\times2\times8)-\frac{4+(4\times2\times10)}{3\times4}=\frac{4+18}{2}+64-\frac{84}{12}=\frac{22}{2}+64-7=68$.

4. $4\times8+\frac{(3\times4)+(3\times6)}{6}-\frac{(3\times4\times10)-(6\times2)}{3\times2\times6}=32+\frac{12+18}{6}-\frac{120-12}{36}=32+\frac{30}{6}-\frac{108}{36}=32+5-3=34$.

5. $(3\times4\times8)+\frac{2\times4}{8-4}+(2\times10)=96+\frac{8}{4}+20=118$.

6. $(3+2)\times(10-8)+\frac{8-4}{8-6}-3=5\times2+\frac{4}{2}-3=9$.

7. $\frac{3\times(6+2)}{10-6}+(3\times4\times2)-\frac{(2+4)\times(8-6)}{10-(4\times2)}=\frac{24}{4}+24-\frac{6\times2}{10-8}=6+24-\frac{12}{2}=24$.

8. $\frac{(3\times2)+(5\times8)}{(2\times10)+3}+8-(2\times4)+\frac{(4\times6-4)\times(3-2)}{10}=\frac{6+40}{20+3}+8-8+\frac{(24-4)\times1}{10}=\frac{46}{23}+0+\frac{20}{10}=4$.

GEOLOGY.—XI.

[*Continued from p. 22.*]

STRATIGRAPHICAL GEOLOGY (*concluded*).—THE PERMIAN SYSTEM—THE SECONDARY AND TERTIARY GROUPS.

THE PERMIAN SYSTEM.

THE period of subsidence during which the Coal-measures were deposited seems to have been followed by one of considerable upheaval, volcanic action, and denudation, a continental period with large inland seas or salt lakes, at least in northern Europe. Thus, whilst in North America, the south of France, and Bohemia, there is a conformable upward passage into Permian beds, in Britain and northern Europe a marked unconformity or stratigraphical break occurs at the top of the Carboniferous rocks, though not accompanied by any great change in the fossils. From their stratigraphical position and prevailing character, the rocks above this break were known as the New Red Sandstone or Poikilitic (Greek ποικίλος, *poikilos*, variegated); but they are now divided into two systems, similar in mineral characters, but separated stratigraphically, and still more so by their fossils. The lower of these is called *Permian* from its extensive development in nearly horizontal strata in Perm and the larger part of European Russia; but in Germany, being divisible into two main series, it is known as *Dyas*. In Russia it consists mainly of sandstones below, with bands of dolomite, gypsum, rock-salt and much copper-ore and of more calcareous beds above, with thin coal-beds throughout. South of the Hartz there is a great series of red sandstones and conglomerates, the *Rothtodtliegende* ("red dead layer"), so called from the local absence of copper, 6,000 feet thick, with contemporaneous lavas and tuffs and some bituminous bands; above this, the *Kupferschiefer* ("copper shale"), a bituminous shale, about two feet thick; and above this, the *Zechstein* ("mine stone") series of limestones, dolomites, gypsum, and rock-salt. The conglomerates are coarse, often brecciated, composed of crystalline and older Palæozoic rocks with ferruginous cement, and show signs of ice scratches. The Kupferschiefer contains fish and plant-remains encrusted with copper, dissolved metallic salts connected with volcanic action having apparently killed the fish and having been reduced by organic action and precipitated as sulphides.

In England Permian rocks have a narrow but continuous outcrop from Nottingham to South Shields, and also occur in the Abberley and Clent Hills in Worcestershire, and in the valley of the Eden, extending into Dumfries and Ayrshire. The Rothliegende or *Lower Red Sandstone*, is 3,000 feet thick in the western basin, where it is known as *Penrith Sandstone*; but only 250 feet in the east. The breccias, which show ice-action, are known as *brockram*. The Kupferschiefer is represented by a thin bed of brown shale, known as *Marl Slate*; and the Zechstein, in the eastern area, by the *Magnesian Limestone*, 600 feet thick. Above this come sandstones with gypsum, believed to be Permian, 600 feet thick at St. Bees in Cumberland, but far less in the east.

The red sandstones are mostly unfossiliferous, but plant-remains, including *Calamites*, *Lepidodendron*, and coniferous wood, and footprints of labyrinthodonts occur in the Lower Permian of the Eden valley. In Germany the yew-like *Walchia* is abundant. The Marl Slate yields a good many small ganoid fish, especially *Palæoniscus* and

Platysomus and the earliest lacertilian *Proterosaurus*. The Magnesian Limestone contains the polyzoan *Fenestella retiformis;* small brachiopods, such as *Productus horridus* and *Spirifera alata;* and small pelecypods, such as *Axinus, Bakevellia,* and *Schizodus;* but the conditions in the salt lakes were certainly not favourable to animal life. The *St. Bees Sandstones* are unfossiliferous, and may be Triassic. Copper and rock-salt in Germany, and magnesian limestone, as a building-stone, in Yorkshire, are the chief products of the system.

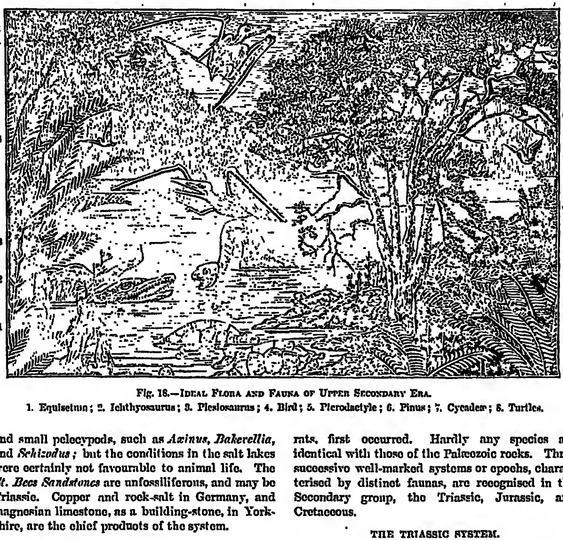


Fig. 18.—Ideal Flora and Fauna of Upper Secondary Era.
1. Equisetum; 2. Ichthyosaurus; 3. Plesiosaurus; 4. Bird; 5. Pterodactyle; 6. Pinus; 7. Cycadeæ; 8. Turtles.

THE SECONDARY OR MESOZOIC GROUP.

Though in central and western Europe the conditions remained much the same after the close of the Permian, and in England there is seldom any marked unconformity between the Permian and the overlying rocks, the change in the character of the fossils is so great as to mark the incoming of a new era. Among plants cycads replace the club-mosses, and among animals brachiopods become less varied, ammonitids and belemnites largely replace the *Nautilidæ*, reptiles soon become prominent, and mammals make their first appearance. In this Secondary or Mesozoic (Greek μέσος, *mĕsos*, middle; ζωή, *zōē*, life) era the fish mostly had *homocercal* (equally-lobed) tails; reptiles became so abundant that it has been termed "the age of reptiles;" and birds and mammals, the latter represented by small forms resembling kangaroo-rats, first occurred. Hardly any species are identical with those of the Palæozoic rocks. Three successive well-marked systems or epochs, characterised by distinct faunas, are recognised in the Secondary group, the Triassic, Jurassic, and Cretaceous.

THE TRIASSIC SYSTEM.

The Trias derives its name from being divisible into three series in Germany. Here, and in Britain, it consists mainly of red sandstones, largely false-bedded and ripple-marked, and loams, with beds of rock-salt, gypsum, and locally limestone, indicating salt lakes in a continental area, as during Permian times, with few fossils, except in the limestones, which mark inroads of the sea. In the Eastern Alps more open-sea conditions are represented by several thousand feet of strata, mainly limestone and dolomite, containing a remarkable admixture of Palæozoic, peculiar, and Mesozoic animal types, and contemporary lavas and tuffs. The Trias is subdivided as follows:—

RHÆTIC, INFRA-LIASSIC, OR PENARTH PASSAGE-BEDS	Marls, black shales, and bone-beds, including the "White Lias."
KEUPER, UPPER TRIAS, OR NEW RED MARL	Red and grey loams and sandstones, with salt and gypsum.
MUSCHELKALK, OR MIDDLE TRIAS	Fossiliferous limestone and dolomite, with salt, etc.; absent in Britain.
BUNTER, OR LOWER TRIAS	Variegated sandstones, loams, with shingles and breccias.

The *Bunter* or variegated sandstone contains footprints of labyrinthodonts, the foliage of cycads, such as *Pterophyllum*, and of the cypress-like *Voltzia*, and stems of *Equisetum*. The *Muschelkalk*, or shelly limestone, of Germany, is often made up of the crinoid *Encrinus liliiformis*, and contains the ammonitid *Ceratites nodosus*. The *Keuper*, or New Red Marl, really consists mainly of loams and sands, with important beds of gypsum and rock-salt, which reach 100 feet in thickness, and a calcareous or dolomitic conglomerate at the base, which sometimes overlaps the lower or Bunter beds. The conglomerate has yielded the earliest known dinosaurian reptiles; and the higher beds, the bones and footprints of labyrinthodonts, many fish-remains, the minute crustacean *Estheria*, the bivalve *Pullastra arenicola*, and the oldest known mammal *Microlestes*. The *Rhætic* or *Penarth beds*, known as Infra-Liassic from forming "passage beds" to the Lias above, are a thin band extending from Dorset to Yorkshire, but best seen in cliffs on the Severn, as at Penarth near Cardiff. They contain a bone-bed full of fish and reptilian remains, a series of "black paper shales" with the Pelecypods *Avicula contorta*, *Cardium rhæticum*, and *Pecten valoniensis*, and the "White Lias" limestone with *Ostrea liassica*. The Triassic rocks range from Devon, where they are about 3,000 feet thick, to Lancashire, where they exceed 5,000 feet, thinning out to less than 1,000 feet in Warwickshire, occupying a large area in the western midland counties, and represented by thin beds in borings near London. Red sandstones at Elgin, only separated from Old Red Sandstone beds by a conglomerate, have yielded lacertilians or lizards, *Telerpeton elginense* and others. The open-sea representatives of the system in the Eastern or Rhætic Alps, near St. Cassian, Hallstadt, and Kössen, contain the Palæozoic *Orthoceras*, *Murchisonia* and *Euomphalus*, with the essentially Triassic *Ceratites* and many species of the more Jurassic genus *Ammonites*. Rock-salt, including that worked at Droitwich, in Cheshire, and near Middlesborough, and gypsum, worked in Derbyshire and Staffordshire, are the more important economic products of the Trias.

THE JURASSIC SYSTEM.

Named from the Jura Mountains, but flanking also the Alps and Apennines, and extending in a broad band with a S.W. and N.E. strike from Dorset to Nottingham and then due north into Yorkshire, the Jurassic system, which follows the Trias conformably, varies very much in thickness, composition, and climatic indications in different areas. With us it consists largely of blue, often dark blue, clays, in distinct layers, the lower portion having thus received the provincial name of Lias and in Germany that of Black Jura; but higher up are important limestones, often coralline and oolitic, whence this portion is called Oolite. In Germany the middle series, being iron-stained, are called the Brown Jura; the upper, the White Jura. The whole system is highly fossiliferous, and this epoch has been termed "the age of cycads, ammonites, and reptiles." Ferns, horse-tails, and conifers, including *Pinites*, *Thuyites*, and *Araucarites*, are also frequent, forming lignite, jet, or true coal. Hexacoralla; pentacrinoids; *Cidaris* and allied echinoids; brachiopods, especially *Terebratula* and *Rhynchonella*; pelecypods, including *Gryphæa*, *Ostrea*, and *Trigonia*; and *Belemnites* abound; but so numerous and short-lived were the *Ammonites* that they have been taken as characterising numerous zones into which the system is divided. At no other period has there ever been such a profusion of reptilian types: *Ichthyosaurus* and *Plesiosaurus*, great sea-lizards, with bony reflecting plates round the eyes; *Pterodactylus* and other bat-like forms, with hollow bones, adapted for flight; the huge Dinosaurs, either herbivorous, or, as in *Megalosaurus*, carnivorous, including *Atlantosaurus*, the largest of land animals, 100 feet long and 30 feet high; besides turtles and crocodiles. The oldest known fossil bird, *Archæopteryx*, has been found in the Upper Jurassic of Solenhofen in Bavaria; and small marsupials, still the only known mammals, represented mainly by lower jaws, occur at two horizons in England, the Stonesfield Slate and the Purbeck series. (*See* Vol. III., page 367.)

The Jurassic system has thus been divided:—

UPPER OR WHITE JURA	Upper Oolite	Purbeckian	
		Portlandian	Portland Stone. Portland Sand.
		Kimeridgian or Kimeridge Clay.	
	Middle Oolite	Corallian.	
		Oxfordian or Oxford Clay.	
		Callovian or Kellaways Rock.	
MIDDLE OR BROWN JURA	Lower Oolite	Bathonian	Cornbrash. Forest Marble and Bradford Clay. Great or Bath Oolite, with Stonesfield Slate. Fuller's Earth.
		Bajocian or Inferior Oolite.	
LOWER OR BLACK JURA	Liassic	Upper, with Supra-Liassic Sands.	
		Middle, or Marlstone.	
		Lower.	

The *Lower Lias* consists of clays, shales, and cement-stones, rich in reptilian remains. The *Marlstone* consists mainly of argillaceous limestone, with a valuable band of clay-ironstone in north-east Yorkshire. The clays of the *Upper Lias*, with *Gryphæa incurva*, pass up into sandy passage beds containing *Rhynchonella cynocephala*. The whole series is rich in well-preserved and mostly marine fossils. The *Bajocian*, named from Bayeux in Normandy, is a variable series represented by marine limestones with *Terebratula fimbria* and *Gryphæa sublobu* in Gloucestershire, estuarine sands rich in iron-oxide near Northampton, and sandstones with coal-seams in Yorkshire and at Brora, Sutherlandshire. At the base of the *Bathonian* near Bath is the argillaceous *Fuller's Earth*, once used for fulling, with *Terebratula ornithocephala*, on which rests the cream-coloured oolitic *Bath Stone*, with *T. maxillata*, with the thin-bedded estuarine flags known in Oxfordshire as *Stonesfield Slate*, containing plants, insects, reptiles, and marsupials, at its base. The *Bradford Clay*, with *Terebratula digona*, in Wilts, and the false-bedded limestone flags of the old forest of Wychwood, known as *Forest Marble*, are local; but the *Cornbrash*, a crumbling or "brashy" fertile band, often less than 10 feet thick, marks continuous sea across England. The *Callovian*, named from Kellaways in Wiltshire, is a calcareous sandstone, containing *Gryphæa bilobata;* but the *Oxford Clay* is an important blue clay, 600 feet thick, containing *G. dilatata* and many well-preserved fossils, and maintaining its character from Sussex borings into Yorkshire. The *Corallian*, characterised by *Cidaris florigemma*, contains the Coral Rag and Coralline Oolite. The *Kimeridge Clay*, named from a Dorsetshire village, is also thick and uniformly developed, often bituminous or lignitic. *Ostrea deltoidea* and the allied *Exogyra virgula* are among its characteristic fossils, and the Solenhofen lithographic limestone, which contains *Archæopteryx*, is on the same horizon. The *Portlandian* is worked for its dead-white oolitic building-stone (as used by Wren for St. Paul's) in the Isles of Portland and Purbeck and near Swindon and Aylesbury. It contains *Trigonia, Ammonites giganteus*, and other marine fossils, largely as casts. There is a gradual upward passage into the estuarine, fresh-water, terrestrial, and marine beds of the *Purbeckian*, a variable series, with "dirt-beds," or ancient soils, containing cycad stems and marsupial jaws; so-called "cinder-beds" made up of *Ostrea distorta;* limestones with turtle, crocodile, and insect remains; shales, with layers of gypsum; beds full of the freshwater mussel *Unio;* and freshwater marbles mainly made up of *Paludina*. The Purbeckian are the oldest beds at the surface in the south-east of England.

THE CRETACEOUS SYSTEM.

Like the Jurassic, the Cretaceous system, though taking its name from what is to us its most familiar rock, the chalk (Latin *creta*), varies very much petrographically. In Europe there were two areas of deposit: the southern, an open-sea area through the Mediterranean region into Asia, represented by massive limestones containing the remarkable group of pelecypods, the *Hippuritidæ;* the north-western, a shallower water area, from Bohemia into Britain, represented by sands and clays—containing phosphatic nodules and largely green from the presence of glauconite—in the lower, and by white chalk in the upper part of the system. In the lower part the plant-remains resemble those of the Jurassic; but in the upper, dicotyledons occur in considerable variety at Aix-la-Chapelle, in Dakota, and even in the north of Greenland. The chalk itself is largely composed of foraminifera, of which *Globigerina* is one of the most abundant. Siliceous sponges were abundant, including *Siphonia* and *Ventriculites*, forming the nuclei of many of the flint nodules, bands of which characterise the Upper Chalk. Corals and crinoids were not abundant; but echinoids are especially so, including *Cidaris, Ananchytes, Micraster*, and *Echinoconus*. *Terebratula, Rhynchonella*, and the pelecypods *Ostrea, Exogyra, Pecten*, and *Inoceramus* are numerous; and, in addition to *Belemnites* and numerous *Ammonites*, we have *Belemnitella* and a great variety of unrolled ammonitids, *Turrilites, Baculites, Hamites*, etc., the last of the group. Among fishes, in addition to elasmobranchs, such as the sharks *Otodus* and *Lamna* and the ray *Ptychodus*, the upper series yields the first teleostean or bony fishes. The chief reptiles are the huge terrestrial herbivorous dinosaur *Iguanodon* and the marine serpent-like *Mosasaurus*, besides the last pterodactyls and ichthyosaurs. No mammals are known; but in Kansas both ratite and carinate birds are represented by toothed forms, *Hesperornis* and *Ichthyornis*.

The Cretaceous system in northern Europe is divided into series named from French localities:—

UPPER CRETACEOUS	Danian or Maestrichtian	Absent in Britain. Yellow chalk of Faxoe, in Denmark, Maestricht, etc.
	Senonian, or Upper Chalk, with flints.	
	Turonian, or Lower Chalk, without flints.	
	Cenomanian	Grey Chalk. Chalk Marl. Chloritic Marl. Upper Greensand.
	Albian or Gault Clay.	
LOWER CRETACEOUS OR NEOCOMIAN	Upper Neocomian, or Lower Greensand.	
	Middle Neocomian, with Tealby beds and Weald Clay.	
	Lower Neocomian, with Hastings Sands.	

The *Neocomian* (from Neocomum, Neuchâtel) is represented in England by beds of two types. In the north the series is made up of the marine *Specton Clay* of Yorkshire, with *Pecten cinctus* in the Middle and *Exogyra sinuata* and *Perna mulletii* in the Upper stage. The Middle, with *Pecten cinctus*, occurs at Tealby, Lincolnshire; but in the south the Lower and Middle are the mainly fresh-water *Wealden* stage, 1,800 feet thick, formed in the delta of a great river from the north-west, 20,000 square miles in area, extending from Dorset to Boulogne (200 miles), and mainly exposed in the valley of elevation between the escarpments of the Lower Greensand in Surrey, Sussex, and Kent, once occupied by a forest ("weald"). The *Hastings Sands*, containing bands of clay, were the source of the Sussex iron (limonite) largely worked from the 16th to the 18th centuries. The *Weald Clay* contains bands of freshwater *Paludina-limestone* known as "Sussex marble," and also yields *Unio* and *Cyrena*, fresh-water bivalves, and the ostracod *Cypris*. The Wealden is succeeded conformably by the *Lower Greensand* or Upper Neocomian, a marine series, subdivided into the *Atherfield Clay*, with *Perna mulletii*; the *Hythe beds* or *Kentish Rag*, containing a valuable building-stone, a sandy limestone, in which *Exogyra sinuata* occurs; the *Sandgate beds*, yielding the Fuller's earth of Nutfield, Surrey; and the *Folkestone beds*, mostly false-bedded silver sands. A slight unconformity and a marked palæontological break separates the Neocomian from the Upper Cretaceous. The *Albian* (from the department of Aube) is represented in England by the stiff blue Gault clay, 100—200 feet thick, full of marine fossils, such as the crab *Palæocorystes*, *Inoceramus sulcatus*, *Hamites*, and various Ammonites, typically exposed at Folkestone and forming a valley between the parallel Lower Greensand and Chalk escarpments, as in the Vale of Holmesdale in Surrey. The *Cenomanian* (from Cœnomanum, Mans) is largely glauconitic. comprising the *Upper Greensand*, or zone of *Pecten asper*, to which belongs the firestone of Surrey; the *Chloritic Marl*, or *Cambridge Greensand*. containing phosphatic nodules, as does also the Lower Greensand, and the red chalk of Hunstanton of the same age; the *Chalk Marl* with *Turrilites*: the *Totternhoe Stone* of Bedfordshire; and the *Grey Chalk* of Folkestone, a very slightly permeable bed, in which it is proposed to bore the Channel Tunnel. The *Turonian*, named from Touraine, includes the Chalk Rock of Dover; and the *Senonian*, named from Sens, includes the Chalk with bands of flints as seen in the cliffs of Thanet and at Norwich. the former containing *Micraster*, the latter *Belemnitella mucronata*. As will be seen by the map, opposite p. 273, Vol. III., the Chalk extends from the downs of Dorset eastward by the Needles through the Isle of Wight, and northward through Salisbury Plain, Hampshire, the Chilterns and the Wolds, to Flamborough Head, dips under the London Basin, and reappears in the North and South Downs, the two escarpments which mark the denudation of the Wealden anticline. The Cenomanian, Turonian, and Senonian together, exceed 1,200 feet in thickness. The *Danian* or *Maestrichtian*. unrepresented in England, seems even in the Paris basin and in Hainault to be an unconformable series, though not in the latter area separated by any marked stratigraphical break from the beds above. It contains the great reptile *Mosasaurus*. The Chalk is slightly represented under Tertiary basalts in north-east Ireland and western Scotland. In India during this period the "Deccan traps," 4,000 to 5,000 feet thick over 200,000 square miles, were erupted. In the western United States Cretaceous rocks reach a thickness of 11,000 to 13,000 feet, and here and in New Zealand there seems to be no great break between them and overlying rocks.

THE TERTIARY GROUP.

In England. the eroded surface of the marine Senonian Chalk covered by the estuarine Thanet Sand or Woolwich Clay with a layer of green flints or "Bullhead bed" at the junction, marks a stratigraphical break and lapse of time unrepresented by rock. Though this gap is more or less completely bridged over elsewhere, the disappearance of *Ammonitidæ* and *Belemnites*, of *Gryphæa* and *Inoceramus*, of *Ichthyosaurus*, *Plesiosaurus*, pterodactyls and dinosaurs, and the coming in of a great variety of new forms, especially siphonostomatous gastropods (*see* Vol. III., p. 367), such as *Voluta*, *Melania*, and *Fusus*, and non-marsupial mammals, first among which were the *Ungulata*, mark the beginning of a new era. The appearance of dicotyledonous plants and teleostean fishes at the base of the Upper Cretaceous serves to remind us that the change was not abrupt. No species, even of the higher invertebrates, has survived from Mesozoic times until to-day; but from the beginning of Tertiary deposits upward we meet with a constantly increasing number of species nearly or quite identical with those of to-day. Hence the group is also called cainozoic (Greek καινός, *kainos*, recent, ζωή, *zōē*, life); and, with reference to its mollusca, it is subdivided into the five systems Eocene (Greek ἠώς, *ēōs*, dawn, καινός, *kainos*), Oligocene (Greek ὀλίγος, *oligos*, a few), Miocene (Greek μεῖον, *meion*, less), Pliocene (Greek πλείων, *pleiōn*, more) and Pleistocene (Greek πλεῖστος, *pleistos*, most).

ENGLISH.—XX.

[*Continued from p. 30.*]

PREFIXES.

You have now learnt something of the suffixes which occur in the English language, and you know that they are additions made after the root of a word. That which is put before the root is in grammar called a *prefix* (from the Latin præ, *before*; and figo, *I fix*).

It will be seen that prefixes (like suffixes) may be of either Romance or English origin.

PREFIXES IN THE ENGLISH LANGUAGE.

A- (*an*), of English origin, has the force of *in* or *on*; as *a*long, *a*longside, *a*back, *a*head, *a*bed. In this sense it is used in connection with present participles, as, *a-hunting*; that is, *in* or *at hunting*. The form occurs in our common version of the Scriptures, in John xxi. 3, being a relic of the language in its older state, though it is now only found in colloquial diction. The phrase may be exemplified, and its meaning shown by comparing together the renderings of different versions of this passage:—

Common Version. Simon Peter saith unto them, I go a fishing.

Wiclif (1380). Symount Petir seith to hem, I go to fische.

Tyndale (1534). Simon Peter sayde vnto them, I will goo a fysshinge.

Cranmer (1539). Simon Peter sayeth vnto them, I will go a fisshinge.

Geneva (1557). Simon Peter sayd vnto them, I go a fysshing.

Rheims (1582). Simon Peter saith to them, I goe to fish.

Authorised (1611). Simon Peter saith vnto them, I goe a fishing.

Not only are these instances curious as exhibiting varieties of spelling, but they seem to show how thoroughly a part of the language is this prefix in the sense now illustrated. Yet is the usage disallowed, and by some regarded as a vulgarism.

This prefix has several other meanings. In *a*foot and *a*main it stands for *on*, and this, as we have seen, is its commonest value. In *a*shamed it represents *of* or *off*, and has an intensive force, while in *a*rise it corresponds to the Anglo-Saxon á. Thus Dryden:—

> "She said; her brimful eyes that ready stood,
> And only wanted will to weep a flood,
> Released their wat'ry store, and poured *amain*,
> Like clouds, low-hung, a sober show'r of rain."

A-, of Romance origin, meaning *from*, is found in the forms *a*-, *ab*-, *abs*-—*e.g.*, *a*batement (French, abattre, *to beat down*), *a beating from* or *down*; *ab*breviation (Latin, brevis, *short*), a shortening; *abs*traction (Latin, traho, *I draw*), *a drawing from* or *away*.

> "But man the *abstract*
> Of all perfection which the workmanship
> Of Heaven hath modelled, in himself contain
> Passions of several qualities."—*Ford.*

A-, of Greek origin, found chiefly in scientific words, has a negative or *privative* force—that is, it reverses the meaning of the word with which it is compounded, as *a*cephalous (Greek, κεφαλή, *head*), *without head*; a term applied in anatomy to the young of any animal born, from original defect of organisation, *without a head*. To avoid the coming together of two vowels, *a*- becomes *an*- before a vowel; as *an*archy, the absence of government; government in Greek being ἀρχή.

Ad-, of Romance origin, *to*, passes into the forms *ac*-, *af*-, *ag*-, *al*-, *an*-, *ap*-, *ar*-, *as*-, *at*-—that is, the terminating consonant of the prefix is, for the sake of ease in pronunciation, changed into the initial consonant of the noun: *e.g.*—

Ad-. "An *ad*journment is no more than a continuance of the session from one day to another, as the word (jou French, *day*) itself signifies."—*Blackstone.*

Ac-. "The greatness of sins is by extension and *accumulation*."—*Jeremy Taylor.*

Af-. "'Tis most true
That musing meditation most *af*fects
The pensive secrecy of desert-cell
Far from the cheerful haunts of men and herds."—*Milton.*

Ag-. "Corporations *ag*gregate consist of many persons united together into one society, and are kept up by a perpetual succession of members, so as to continue for ever."—*Blackstone.*

Al-. "Then by libel (libellus, *a little book*), or by articles drawn out in a formal *al*legation, set forth the complainant's ground of complaint."—*Blackstone.*

An-. "This god-like act
*An*nuls thy doom." *Milton.*

Ap-. "God desires that in His church, knowledge and piety, peace and charity, and good order should grow and flourish; to which purposes He hath *ap*pointed teachers to instruct and governors to watch over His people."—*Barrow.*

Ar-. "*Ar*rogant is he that thinketh he hath those beauties in him that he hath not."—*Chaucer.*

As-. "Are you discontent
With laws to which you gave your own *as*sent?"—*Pope.*

At-. "The most wise God hath so *at*tempered the blood and bodies of fishes, that a small degree of heat is sufficient to preserve their due consistency and motion, and to maintain life."—*Ray.*

Amb-, of Latin origin, signifies *on both sides*, as *amb*idextrous (Latin, dexter, *the right hand*), literally, *having a right hand on both sides*—that is, one who uses his left hand equally well with the right. Sometimes this suffix occurs as in the form *am*-, as in *am*putate.

> "Should I that a man of law
> Make use of such a subtile claw,
> In London or in Exeter;
> And be *of both sides*, as you were,
> People would count me then, I fear,
> A knavish ambodexter."—*Brome.*

Amphi- is a Greek prepositional suffix, and only in words derived directly from the Greek, as *amphitheatre*, a theatre of two sides or circus; *amphibious*, double-lived—that is, living on land and in water.

Ana-, of Greek origin, *up, back*, as in *anachronism* (Greek, χρόνος, *time*), an error in date by which an event is placed too high up or too far back; generally a deviation from the order of time.

"The dressings and buildings of the time are preserved, though by frequent anachronisms."—*Walpole.*

Ana- is found also in *anagram* (Greek, γράμμα, *a letter*), which is a word produced by the transposition of its letters, having a meaning different from the original.

"And see where Juno, whose great name
Is Unio in the anagram,
Displays her glittering state and chair."—*Ben Jonson.*

Ante-, of Latin origin, *before*, as *antedate*, to date before time, to anticipate—

"Andromache, my soul's far better part,
Why with untimely sorrows heaves thy heart?
No hostile hand can *antedate* my doom,
Till fate condemns me to the silent tomb."—*Pope's Homer.*

Anti-, of Greek origin (ἀντί, *against*), *in opposition to*, as in antichrist, *opposed to Christ*—

"If once that antichristian crew
Be crush'd and overthrown,
We'll teach the nobles how to crouch,
And keep the gentry down."—*Quarles.*

In theology, *antitype* stands correlatively over against *type*, as the counter-pattern to the pattern, the corresponding and completing form.

"The Mosaic law was intended for a single people only, who were to be shut in, as it were, from the rest of the world, by a fence of legal rites and *typical* ceremonies; and to be kept by that means separate and unmixed until the great *antitype*, the Messiah, should appear, and break down this fence and lay open this inclosure."—*Atterbury.*

The *i* in *anti-* is sometimes dropped before a vowel, as in *antarctic*, which means opposite to or over against the north.

Apo-, of Greek orgin, *from*; as *apostle*, from the Greek, ἀπό, *from*, and στέλλω, *I send*—that is, a person sent from one to another, a messenger.

Apo- has the force of our English prefix *un-*, as in *un*cover. This is its exact import in the word apocalypse, *a revelation*, from the Greek, ἀπό, and καλύπτω, *I conceal*—that is, according to the Latin, an *unveiling*; and according to the Greek, an *uncovering*.

"O for that warning voice which he who saw
Th' *apocalypse* heard cry in heaven aloud."—*Milton.*

Arch-, of Greek origin (from ἀρχή, *a beginning*), is found prefixed to many words of Greek derivation. It occurs in English in the forms *arch-*, *arche-*, and *archi-*, denoting the *origin*, the *head*, and hence *government*. Examples of it are *arch*bishop, *arch*angel, *ache*type, *archi*trave, etc.

Besides a *type* and an *antitype*, theology recognises an *archetype*, or *original type*, an original mould or model, in which, and after the likeness of which, all created beings were formed.

"There were other objects of the mind, universal, internal, immutable, which they called original ideas, all originally contained in one *archetypal* mind or understanding, and from thence participated by inferior minds and souls."—*Cudworth.*

Auto-, of Greek origin, equivalent to *self*, is found in *autocrat*, from the Greek, αὐτὸς, *oneself*, and κρατέω, *I rule*, one who governs of himself and by himself; hence *autocracy* is arbitrary power, despotism.

"The divine will is absolute; it is its own reason; it is both the producer and the ground of all its acts. It moves not by the external impulse, or inclination of objects, but determines itself by an absolute *autocracy*."—*South.*

Be-, a prefix of English origin, in the forms *be-* and *by-*, is connected probably with the preposition *by*, performs the part of an intensive, and increases, sometimes in a bad sense, the inherent import of a word—*e.g.*, *be*loved, *be*daub, *be*smear, *be*praise. In other cases it changes an intransitive into a transitive verb, as *be*think, or a noun into a verb, as *be*friend, *be*troth. It is also found in some adverbs, as *be*hind (hind, hinder), *be*fore, *be*low, *be*neath. It may be recognised in the following nouns, *be*half, *be*hest, *by*stander, *by*word, etc.

Bi-, in the forms of *bi-* and *bis-*, of Romance origin (bis, *twice*), has in English the force of *two* or *twice*; *bi*ped (pes, Latin, a *foot*), *two*-footed, *bis*cuit (cuire, French, *to cook*), *twice-cooked*.

"The inconvenience attending the form of the year above mentioned was in a great measure remedied by the Romans in the time of Julius Cæsar, who added one day every fourth year; which (from the place of its insertion—viz., after the sixth of the calends of March) was called *bissextile* or leap-year."—*Priestly, on History.*

Cata-, of Greek origin (κατὰ, *down*), properly denotes motion in a downward direction, and appears in the word *cat*aract (from the Greek κατὰ and ἀράσσω, *I dash down*), which, according to its derivation, signifies a *breaking-down*—that is, of the rock which leads to a downfall of water. This prefix is found in other words of Greek origin, as in *cata*clysm (from the Greek κατακλυσμός, *a deluge*, from the verb κατακλύζω, *I inundate*), a term applied to the deluge. As we have seen in *cat*aract, when *cata-* precedes a vowel it is abbreviated to *cat-*, and when it precedes an aspirate it is changed to *cath-*, as in *cath*olic.

"The *catacombs* are subterranean streets or galleries from four to eight feet in height, and from two to five in breadth, extending to an immense and almost unknown length, and

branching out into various walks under the city of Rome."—*Eustace.*

Circum-, of Latin origin, signifies around, as in *circum*stances (from *circum-*, and the Latin verb sto, *I stand*), literally *the things which stand around you;* what has been called a "man's surroundings." *Circum-* enters into the composition of many words—*e.g.*, *circum*navigation, *circum*locution, *circum*spect, *circum*scribe, etc.

"The *circumscription* of a thing is nothing else but the determination or defining of its place."—*More.*

Cis-, of Latin origin, signifying *on this side of* (Rome being considered the centre), is found in *Cis*alpine, *this side of the Alps*, in opposition to *Trans*alpine, on *the other side of the Alps.* *Gallia Cisalpina* was what we call Lombardy; *Gallia Transalpina* was Gaul or France.

Co-, of Romance origin (cum, *with*), occurs in the forms *co-*, *col-*, *com-*, *con-*, *cor-*. These various forms of the same prefix have the same meaning, and the change of form is due to phonetic considerations; indeed, the prefix may be said to vary according to the initial letter of the word to which it is prefixed.

Co-, as in *co*alesce (from *co-* and alesco, Latin, *I grow*), *to grow together;* it is found in the derivatives *co*alescence, *co*alition.

"No *coalition* which, under the specious name of independency, carries in its bosom the unreconcilable principles of the original discord of parties, ever was or will be a healing coalition."—*Burke.*

Co- may also be observed in *co*gnate (Latin gnatus, *born*), *born with*, of the same family or kind; and in *co*gnition (Latin gnosco, *I know*), *knowledge;* a means of knowing, a *cognisance* or token.

"For which cause men imagined that he gave the same in his full brightness for his *cognisance* or badge."—*Hall*, "*Henry IV.*"

Col-, as in *col*loquial (Latin loquor, *I speak*), *relating to conversation;* as also in *col*lusion (Latin ludo, *I play*), a *playing together*—that is, deception.

"Well, let us now leve the cloked *collusion* that remayned in Fraunce, and return to the open dissimulacion which now appeared in Englande."—*Hall.*

Com-, as in *com*memorate (Latin memor, *mindful*), to *keep in mind*, to *recall to mind;* found in *com*mensurate, *com*minute, *com*mute, *com*pact, etc.

"A different spinning every different web
Asks from your glowing fingers; some require
The more *compact*, and some the looser wreath."
Dyer, "*Fleece.*"

Comb-, as in *comb*ustion (Latin uro, *I burn*).

Cor-, as in *cor*rect (Latin rego, *I rule*), and *cor*respond, *cor*rode, *cor*rupt, *cor*rugate (Latin ruga, *a wrinkle*).

"The full lips, the rough tongue, the *corrugate* cartilaginous palate, the broad cutting teeth of the ox, the deer, the horse, and the sheep, qualify this tribe for browsing upon their pasture."—*Paley*, "*Natural Theology.*"

Contra-, of Latin origin (contra, *over against*), is seen in *contra*band (bannum, low Latin, *a decree, law*), *against the law*, smuggled; and in *contra*dict. It appears as *contro-* in *contro*versy, and before a vowel it loses the *a* as in *contr*-alto. *Contra-* appears in another form—namely, *counter-*, *counter*feit (from counter, contre, and faire, French, *to make*), and in *counter*pane, a *covering.*

"On which a tissue *counterpane* was cast,
Arachne's web the same did not surpass,
Wherein the story of his fortunes past
In lively pictures neatly handled was."
Drayton, "*The Barons' Wars.*"

De-, of Romance origin, denoting motion downward, has, in combination, the following meanings, being modifications of its original import:—

1. *Down*, as in *de*crease; *de*throne, to put down a king.

"The question of *dethroning* or cashiering of kings will always be an extraordinary question of state, and wholly out of the law."—*Burke.*

Also in *de*base (from *de-*, and battre, French, *to beat*), which originally meant to lower in regard to material things: *e.g.*—

"King Edward III., in the sixteenth year of his reign, proclaimed that no man should sell woolfels or leather under such a price, so that these staple commodities might not be *debased.*"—*State Trials*, 1604.

The application of the word *debase* to a moral influence is exemplified in the following passage:—

"So let her go. God sent her to *debase* me,
And aggravate my folly, who committed
To such a viper his most sacred trust
Of secresie, my safety, and my life."
Milton, "*Samson Agonistes.*"

2. *From*, as in *de*bar, *to bar or keep from, to prevent.*

"His song was all a lamentable lay
Of great unkindnesse, and of usage hard,
Of Cynthia, the Ladie of the Sea,
Which from her presence faultlesse him *debard.*"
Spenser, "*Colin Clout.*"

3. *Out, thoroughly*, as in *declare* (*de-* and clarus, Latin, *clear*), in which the prefix has the form of an intensive; to make clear—that is, by utterance.

4. *Not*, with a force like *un-* in *un*do, reversing the sense; as, *decompose*, to do the opposite of composing—that is, compounding; *decollation* (*de-* and collum, Latin, *the neck*), un-necking—that is, beheading; *decorticate* (*de-* and cortex, Latin, *bark*), to strip off the bark; *de*fame, etc.

"Blesse ye men that cursen you, preye ye for men that *defamen* you."—*Wiclif*, "*Test.*" Luke vi.

Demi-, of Latin origin, in the forms *demi-*, *semi-*, *a half*, is found in *demi*-god and in *semi*breve.

"Thou wouldst make an absolute courtier, and the firm fixture of thy foot would give an excellent motion to thy gait, in a *semi-circled* farthingale."—*Shakespeare.*

Dia-, of Greek origin, *through*, is found in *dia*meter, a *measure through*, from one side of the circle to the opposite; in *dia*gonal, a line drawn from corner to corner; in *dia*logue, etc.

> *Var.* How dost, fool?
> *Ape.* Dost *dialogue* with thy shadow?
> *Var.* I speak not to thee.—*Shakespeare.*

Dia- is abbreviated into *di-* before vowels, as in *di*æresis. In *devil*, which is derived from διάβολος, it appears as *de-*, while in *dea*con (from διάκονος), it has the form *dea-*.

Dis-, a Romance prefix, may be rendered by the phrase, *in two directions*, or in different ways, as in *dis*tract (from *dis* and traho, *I draw*). *Dis-* is found in these forms—namely, *di-*, *dif-*, *dis-*, *des-*, and *de-*, as *di*vagate, *dif*ferent, *dis*tract, *des*cant, and *de*feat. The word *spend* is interesting, because it shows us how the prefix may sometimes be almost whittled away. The *s* of *spend* is all that is left of *dis-*. The Latin form was *dis*pendere.

> "And for there is so great *diversitie*
> In English, and in writing of our tong,
> So pray I God that none miswritè thee,
> Ne misse the metre for defaut of song."
> *Chaucer.*

Sometimes the prefix *dis-* has a negative force, as in *dif*ficult, which comes from *dis-* and *facilis*, and *dis*please.

E-, of Latin origin, in the forms *e-*, *ef-*, *ex-*, denotes *out of*, as in *e*gress (*e-* and gradior, Lat. *I walk*), *a walking out; excess* (*ex-* and cedo, *I go*), *a going beyond*—that is, too far; *ef*fect (*ef-* and facio, Lat. *I do*), *a thing made out, produced; a result.* See *Es-*.

E-. "All occasions must be taken of sending forth pious heavenly *e*jaculations to God."—*Bishop Hall.*

Ef-. "Two white sparry incrustations, with *ef*florescences in form of shrubs, formed by the trickling of water."—*Woodward.*

Ex-. "The ecclesiastical courts possessed the power of pronouncing *ex*communication; and that sentence, besides the spiritual consequences supposed to follow from it, was attended with immediate effects of the most important nature. The person *ex*communicated was shunned by everyone as profane and impious; and his whole estate, during his lifetime, and all his movables, for ever, were forfeited to the crown."—*Hume.*

In the following passages you will find plenty of examples which will illustrate the lesson you have just read. You will find it a useful exercise to write out the anecdotes, after you have read them, in your own words:—

A PARDON AT THE RIGHT MOMENT.

On the 29th of May, the whole garrison was paraded on the Castle Hill at Edinburgh, and formed in three sides of a hollow square, facing inwards. With drums muffled and rolling, while the band played a solemn dead march, three of the Highland recruits, each stepping slowly behind his open coffin, were brought by an armed escort down the winding pathway from the citadel, and placed in the vacant space of the square, opposite a numerous firing party under the orders of the provost-marshal. It was a bright and beautiful summer morning, but there was a dark cloud on every face, for no ceremony is more impressive and terrible than a military execution—and on that morning three soldiers were to die. They were desired to kneel down beside their open coffins, while the following paper was read by the adjutant-general:—

"*Garrison Orders.*

"Head-Quarters, 6th May, 1779.

"At a general court-martial, held in Edinburgh Castle, on Thursday, the 6th May, and two following days, whereof Lieut.-Colonel Dundas, of the 11th Dragoons, was president, for the trial of Charles Williamson and Archibald Mac-Ivor, soldiers of the 42nd Regiment, and Robert Budge, soldier of the 71st Regiment, accused of mutiny, at Leith, on the 20th April, and instigating others to do the same, the court unanimously found the prisoners guilty of mutiny, being a breach of the 1st, 2nd, 3rd, 4th, and 5th articles of war; and having duly considered the evil tendency of mutiny and sedition, especially when carried to such enormous lengths as in the present case, do adjudge you, the aforesaid Charles Williamson, Archibald Mac-Ivor, and Robert Budge, *to be shot to death!*"

The poor prisoners remained on their knees while a Highland officer translated the foregoing into Gaelic. They were all pale and composed but the last, who was suffering from severe wounds received at Leith; his countenance was emaciated and ghastly, and he was sinking from excessive debility. Their eyes were bound up; the officer retired; the provost-marshal approached, and ordered his party to load. They were in the act of taking aim at the prisoners, who were praying intently in Gaelic, when Sir Adolphus Oughton stepped forward, and, displaying three pardons, commanded them to "recover arms." "Soldiers," said he, "in consequence of the distinguished valour of the Royal Highlanders, to which two of these unfortunate men belong, His Majesty has been graciously pleased to forgive them all. Prisoners! rise, resume your arms, and rejoin your companies." An officer repeated these words in Gaelic. The scene and the whole proceedings were so solemn and affecting that the prisoners were incapable of speech. Raising their bonnets, they endeavoured to express their gratitude by a faint cheer, but their voices utterly failed them; and, overcome by weakness, and a revulsion of feeling, the soldier of the 71st sank prostrate on the ground between the coffins.—"*Memorials of the Castle of Edinburgh.*"

A WHALER IN A STORM.

About eleven o'clock, I ventured on deck, and for the first time in my life saw what the ocean looks like in a storm. I could see nothing all round but heaving mountains of water; each succeeding wave seemed as if it would swallow up the labouring vessel, but it always appeared to melt away gently under us, except when one more rapid, or "cross," would send water and spray washing over her decks and high up into the rigging. The motion of the ship was not uncomfortable, being very different from the short cross-pitching we had experienced in the North Sea. I remained on deck about a quarter of an hour, gazing about me in silent wonder and admiration, little thinking that the hitherto harmless waves

were upon the very eve of proving their might over man's puny bolts and beams. Feeling it chilly, I went below. I had just entered the cabin and taken my seat, when the ship became motionless, as it were, and seemed to tremble in every beam. A report, like thunder, mingled with the rending and crashing of timber; sudden and complete darkness, with a rush of water through the skylight, and the ship thrown on her beam-ends, showed me what one has to expect occasionally at sea. I scrambled on deck after the captain, as I best could, scarcely knowing what had happened. Here nothing was to be seen but wreck and destruction. The quarter-deck was literally swept of everything—rails and bulwarks, almost all the stanchions, the binnacle, the compasses, dog's couch—and nothing could be seen of the wheel but the nave. But the worst was still to come; two poor fellows were missing. One had perished unnoticed; he must have been killed amongst the wreck, washed overboard, and sunk like a stone. The other had been seen by the mate—for an instant only—floating on the binnacle and just sinking. No human assistance could have been rendered to them with such a sea running. Two other poor fellows were rather seriously injured, and took up my attention for some time. The captain, cool and collected, soon restored confidence to his men, and, in a short time, had the wreck cleared away, a long tiller shipped, and the vessel again hove to. Spare spars were lashed to the stanchions that remained, so that we again had something like bulwarks, but for many a day afterwards the ship had a sadly damaged and wrecky appearance.—*Goodsir's Arctic Voyage.*

GEOMETRICAL PERSPECTIVE.—V.

[*Continued from p. 35.*]

PROBLEMS XXIV.—XXVII.

PROBLEM XXIV. (Fig. 45).—*Draw the perspective view of a flight of three steps, each 4 feet long, 1 foot wide, and 9 inches high; their front making an angle of 40° with the picture plane. The distance of the eye of the observer from the picture plane is 6 feet, from the plane to the nearest point of the object 1 foot. The height of the eye 4·5 feet. Scale at pleasure.*

From *a* in the picture plane, draw the line *a b*, at 40° with P P. From *e*, one foot within the P P, make *e b* equal to the *length* of the steps, and *c d* equal to the width of the three steps divided in *e* and *f*. The heights to be marked presently on the line of contact. There will be no difficulty in drawing the rest of the plan. Place the station point, S P, draw the base of the picture, and the H L three feet and a half above the base, and find the vanishing point. Bring down visual rays from the ends of the steps at both extremities of the plan. Produce *d c* to *h*, and *g b* to *k* for points of contact, and bring them down perpendicularly for *lines of contact*. From the base *i* on *i h* mark the heights of the three steps one above the other, and also from *m*, on *m k*, numbered on both lines 1, 2, 3, and from each of these divisions draw retiring lines to the V P, which, being cut by the visual rays, will give the respective points upon which to draw the ends of the steps, marked again *e*, *e*, *f*, and *d*; their fronts and edges extend between the corresponding visual rays drawn from the *g b* end of the plan.

PROBLEM XXV. (Fig. 46).—*A rectangular block of masonry 24 feet long, 20 feet high, and 16 feet broad, is pierced by an arch springing at a height of 10 feet, and of semicircular form, with a span of 12 feet. Let the point of view be on one side of its centre. Distance within the picture plane 2 feet. Height of eye 8 feet. Station point from the picture plane 26 feet. Scale 5 feet to the inch.*

We will first draw the perspective view of the arch when the front is parallel with the picture plane. If the pupil has not a scale of inches divided into fifths, he can easily construct one in this manner:—Draw a line, say 6 inches long, to represent 30 feet, and divide it into three equal parts; divide the first division into ten parts, which will represent single feet, and the main divisions will represent tens of feet. Number it similarly to the scales given in lesson I., Vol. III., p. 215.

Draw the P P, and two feet beyond, and parallel with it, draw the line *a b* equal to 24 feet; *a c* 6 feet, and *e d* 12 feet. Draw *a e* equal to 16 feet, and complete the rest of the plan as shown in the figure. Place the point *f* a little to the right of the centre, and draw the line *f* S P, making *g* S P equal to 26 feet. Draw the line B P (base of the picture) anywhere below the P P, allowing sufficient room for the elevation between the base of the picture and the plan above, also the horizontal line 8 feet from B P. Draw visual rays from *a*, *e d*, *b*, *h*, *i*, and bring them down perpendicularly from the P P. Draw *a k* perpendicularly to the P P, for the line of contact or measuring line for the heights; mark the P S (point of sight) and draw *km* from *k* towards P S, stopping at the V R from *a*. Draw *m n* parallel to B P, which will be the perspective front of the base of the building. The visual rays from *c* and *d* will determine the width of the arch *o p*. Make the distance *k r* for the height equal to 20 feet. Draw *rs* from *r* as was done from *k*, and draw *s t* for the top of the building. At *u*, ten feet from *k*, draw *u y* towards the P S, and also *y v w*; bisect *v w*; from *x* as a centre being brought down from *q*, draw the semicircle *v w*; the front of the building will then be completed. For the other end of the arch which spans *h i* of the plan, draw lines *v l*, *w z*, from *v* and *w* to P S, meeting the visual rays from *h* and *i* in *l* and *z*; join *l* and *z*, and either bisect it, or draw a line from *x* to P S, which, cutting *l z*, will give the centre point from which the interior or further end of the arch must be drawn with a radius from the centre to *l* or *z*. For the

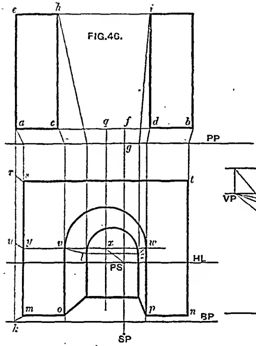


FIG.46.
PP
HL
PS
BP
SP

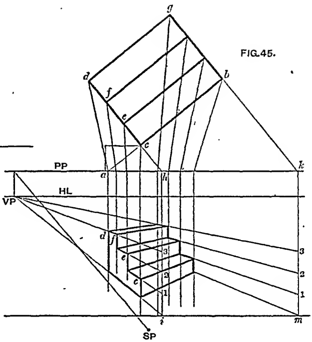


FIG.45.
PP
HL
VP
SP

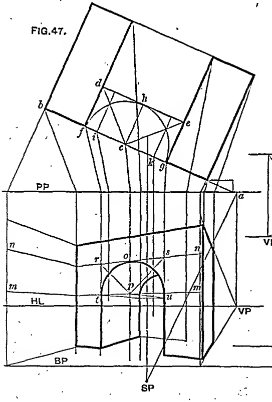


FIG.47.
PP
HL
VP
BP
SP

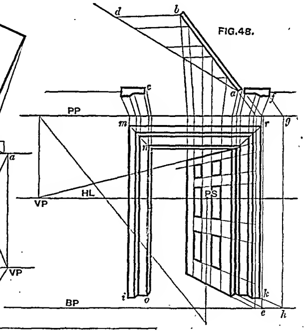


FIG.48.
PP
HL
VP
PS
BP

were upon the very eve of proving their might over man's puny bolts and beams. Feeling it chilly, I went below. I had just entered the cabin and taken my seat, when the ship became motionless, as it were, and seemed to tremble in every beam. A report, like thunder, mingled with the rending and crashing of timber; sudden and complete darkness, with a rush of water through the skylight, and the ship thrown on her beam-ends, showed me what one has to expect occasionally at sea. I scrambled on deck after the captain, as I best could, scarcely knowing what had happened. Here nothing was to be seen but wreck and destruction. The quarter-deck was literally swept of everything—rails and bulwarks, almost all the stanchions, the binnacle, the compasses, dog's couch—and nothing could be seen of the wheel but the nave. But the worst was still to come; two poor fellows were missing. One had perished unnoticed; he must have been killed amongst the wreck, washed overboard, and sunk like a stone. The other had been seen by the mate—for an instant only—floating on the binnacle and just sinking. No human assistance could have been rendered to them with such a sea running. Two other poor fellows were rather seriously injured, and took up my attention for some time. The captain, cool and collected, soon restored confidence to his men, and, in a short time, had the wreck cleared away, a long tiller shipped, and the vessel again hove to. Spare spars were lashed to the stanchions that remained, so that we again had something like bulwarks, but for many a day afterwards the ship had a sadly damaged and wrecky appearance.—*Goodsir's Arctic Voyage.*

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[*Continued from p. 35.*]

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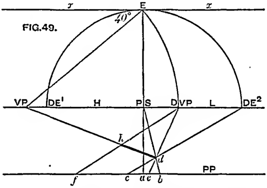
spective elevation of a house or other building is all that is required; in this case a plan would be useless, and the *lineal* method would be the most convenient, as it saves the labour of making a plan for the sole purpose of raising an elevation from it.

The picture plane, the horizontal line, vanishing points, station point, line of contact, or measuring line for heights, and point of sight, are common to both methods; therefore we need not recapitulate our remarks upon them; that which will be especially new to our pupils is that the angle of inclination which an object makes with the picture plane is *described*, instead of drawing it in plan. *Visual rays* will not be required, as *the retiring length of an object is cut off the vanishing line by the help of its distance point, marked* D P. The nearest approach to this system which we have yet made is shown in lesson III., Vol. III., p. 342. It is true we have there made use of a plan, but there are no visual rays (*see* Figs. 22, 26). The plan has been introduced solely for the purpose of obtaining by construction the positions of the extremities of the lines upon the picture plane. Let us take Fig. 23, and we shall here see that the position of the line H I in the picture is ascertained by finding the positions of the two extremities only. Thus the points *h* and *i* being determined as the perspective representations of H and I, the completion of the line follows by drawing a line between the two points. Now these positions can be given without the necessity of a plan, as we are about to explain.

We think we shall be able to make our explanations clearer, and better understood by our pupils, if we propose a problem at once, and during the process of drawing, accompany the explanations of the work with our observations upon the theory, at the same time employing the figure as we draw it to illustrate our remarks.

PROBLEM XXVII. (Fig. 49).—*A pole 4 feet long is lying on the ground, and is inclined to the picture plane at an angle of* 40°; *its nearest end is* 2 *feet within the picture, and* 1 *foot to the right of the eye; distance of the eye from the* P P *is* 6 *feet, and* 4 *feet from the ground; scale* 1 *inch to the foot.*

Draw the picture plane, P P, and the H L parallel with the P P and 4 feet above it. Anywhere upon the H L mark the P S (point of sight). From P S as a centre, and with the distance of 6 feet in the compasses, draw the semicircle DE^1, DE^2. Before we go any farther we will examine this. To assist in understanding the position and meaning of this semicircle we refer back to Fig. 21, lesson III., Vol. III., p. 342. There it will be seen that E represents the eye, and its distance from the P P from E to P S. Of course P S is opposite the eye E, and a line between the two would form right angles with the P P. Now *it is necessary to set off on the* H L *the distance of the eye from the* P P, that is, the distance from E to P S, for a reason to be explained presently; therefore, the proper way to do that is to draw a semicircle, and mark the extremities meeting the H L as DE^1 and DE^2. In the eidograph (Fig. 21), the dotted semicircle through the eye E (ending on one side at DE^1 and the other at DE^2) is in a *horizontal* position; it is afterwards supposed to be turned up, or rabatted, upon the P P passing through E^2 (to the same points). This will be the position in which we shall place it for the future, and as seen in the figures which immediately follow Fig. 21. To proceed with Fig. 49: draw a line $x\ x$



tangential to the semicircle, and parallel to the H L or P P. Our problem states that the *inclination of the pole* to be represented *is at an angle of* 40° *with the* P P. Therefore, from E draw a line at that angle with $x\ x$, meeting the H L in V P. There will be no difficulty in comprehending this, if we consider that because $x\ x$ is parallel with the P P, therefore if the plan of an object is known to be at a certain angle with the P P (as in the ground-plan method), it will form the same angle with $x\ x$. This, then, is the way a V P is found without the necessity of a plan. From P S draw the perpendicular P S *a*, and mark *one* foot to the right of *a*, viz., *a b*, because the nearest end of the pole is 1 foot to the right of the eye. Draw *b* P S, and somewhere upon *b* P S will be found the position of the nearest end of the pole, to be determined in the following manner:—From *b* set off *b c* equal to 2 feet, draw a line from *c* to DE^2, cutting *b* P S in *d*, the point required. This, with the exception of the plan, is precisely the same that was done with the line A B in Fig. 23, that is, by making C D equal to C A, *a* was found to be the nearest end of the line A B. We now come to a stage of the proceedings which will demand the closest attention of our pupils. It is that *of cutting off a portion of a vanishing or retiring line*, to give the perspective length of the object, in this

base of the interior of the archway draw lines from o and p, towards P S, cutting the visual rays from h and i; join these points by a line parallel to B P; this will complete the perspective elevation.

Fig. 47.—*We will now draw the same subject at an angle with our position. Let the angle of the front of the building be 24° with the* P P. *The other conditions as before.*

Draw a b at an angle of 24° with P P, and complete the plan upon a b, as in the last figure. We will use one V P, as in Figs. 40, 41, 45, and some others. We trust, after all that has been said upon the method of drawing an object with the use of one V P, the pupil will have no difficulty in first drawing the perspective of the block. The principal difficulty will be with the arch, to draw which we shall have to repeat the same principles which were employed for the circle on the board (Problem XX., Fig. 40, p. 32); therefore, in order to get the necessary points through which the arch is to be drawn *by hand*, we must rabat the semicircle. From e as a centre draw the arc f h g; draw d h e parallel to f g. and the semi-diagonals c d and e e through the points where these last lines intersect the arc: draw lines parallel to f d to meet the front of the plan of the building in i and k; visual rays must be drawn from g, k, c, i, f. From the spring of the arch marked on the line of contact at m, make m n equal to f d; the visual ray from c the centre will produce the points o and p; draw the semi-diagonals p r and p s; where these last lines intersect the visual rays from i and k, will give the points through which the arch t o u must be drawn *by hand*. We have not entered into the other part of the work, as we have no doubt that our pupils will be able to do it from the experience they have gained in the solution of previous problems.

PROBLEM XXVI. (Fig. 48).—*Give a perspective view of a door-frame, a six-panelled door, partly open, the door-frame being parallel to the plane of the picture, and the line of sight two-thirds of the height of the door.* (From a Military Examination Paper.)

There are very few conditions given. The door is said to be partly open, therefore it may be placed at any angle at pleasure; the wall and door-frame may be placed at any distance from the P P, but they must be parallel to the P P; the proportions of the door and frame are discretionary. This is one of those problems which are frequently given at public examinations with very few working conditions. It gives us an opportunity for advising all who may at any time have to compete in these examinations to use some definite scale in the construction; it will probably save a great deal of confusion and much uncertainty. There will be much in the drawing of this subject that has occurred before, all of which we shall pass over to avoid unnecessary repetition of former instructions. In the plan it must be observed that the width of the door a b must be made equal to a c, the space within the frame. The division of a b for the plans of the stiles and panels must be *proportionately* divided, and those proportions must be set off on a d. (*See* Geometry, lesson VI., Vol. I., p. 371.) There are *three lines of contact;* the first is from a b produced to the P P. Upon this line of contact all the perpendicular measurements of the stiles and panels are arranged. The *second line of contact* is from the back of the door produced to the P P. This is for the purpose of arriving at the *perspective thickness* of the door; therefore from the bases of these two lines of contact at e retiring lines are drawn to the V P; these retiring lines, cutting visual rays drawn from the end of the door a in the plan, will give the perspective thickness of the door. The principal retiring lines are those of the top and bottom of the door, and the horizontal edges of the panels, all drawn from the perpendicular measurements above stated. The third line of contact is g h; f g being made parallel to a b for the sake of the advantage of the same V P; a line drawn from the base of g h towards the V P, cutting a V R from f, gives the position of the base of the frame i k. The width of the frame across the top is obtained thus:—n o being the height of the opening of the door, a line must be drawn from n to m at an angle of 135° with n o; consequently, after m r is drawn, m n will be found to bisect the right angle r m i; therefore, the visual rays from the plan of the frame at e cutting the line m n will produce the points in m n from which to draw the mouldings both horizontally and perpendicularly; P S will be the V P for the interior edge of the frame, as shown in the line drawn from o. The great advantage of using several lines of contact will be seen when working the details. We allude to this for the purpose of observing that it is advisable to draw these lines of contact from produced lines of the plan *all parallel with each other*, so that one vanishing point may be used for all; otherwise, if they are *not* parallel, other vanishing points will have to be found, because *every retiring line* must have its *own* vanishing point.

Our previous lessons in Perspective have been upon the *ground-plan* method; we will now introduce to our pupils the *lineal* method—we call it the *lineal* because its results depend upon the *projection of planes and angles* without the intervention of a plan. It sometimes occurs that a per-

preparation of a powerful antisyphilitic, purgative, and diuretic medicine. It was introduced to notice in this country from North America in 1883.

Frankenia grandifolia.—An herbaceous plant of California. Under the name of YERBA REUMA it was introduced in 1879 as a remedy in catarrh, mucous discharges, and in ophthalmia.

Gouania domingensis.—A climbing West Indian shrub belonging to the natural order Rhamnaceæ. It has long been known as CHEW STICK, and used when pulverised as an ingredient in tooth powder. Pieces of the stem, with one end beaten into fibre, have also been used as tooth brushes. These stems appear to contain saponine. In the West Indies the whole plant is considered a good antiseptic; a decoction of the roots has been used in dropsy. It was introduced to notice in this country about 1881 for use in the preparation of an astringent gargle,

Gynocardia odorata.—A large tree of India bearing a globular fruit about the size of a large orange, and containing numerous seeds, the oil of which is expressed and known as CHAULMUGRA oil. This oil has been used in India for a very long time in skin diseases, affections of the joints, etc. It was not, however, till 1878 that the oil began to attract much attention in England, when experiments were made in many of the London and provincial hospitals, as well as in private practice, to test its efficacy in rheumatic affections, skin diseases, consumption, syphilitic affections, etc.; it was used both externally and internally, the latter in the form of capsules. A certain amount of success seems to have attended its use, but of late years it has ceased to attract so much notice.

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Hemidesmus indicus.—A twining shrub of India and Ceylon. The roots are known as INDIAN SARSAPARILLA, and have been used for a long period in native medicine in India. They are said to have alterative, tonic, diuretic, and diaphoretic properties, and were introduced into the British Pharmacopœia in 1864. They are, however, very rarely employed in this country.

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Mentha arvensis, var. *piperascens.*—A Chinese herb belonging to the Labiatæ. It yields an oil which contains a large quantity of a crystalline substance known as MENTHOL or PEPPERMINT CAMPHOR. This substance began to attract attention in 1879, since which time Menthol has become an increasing article of trade, and is much used in cases of neuralgia, toothache, etc., by rubbing it on the parts affected. A similar crystalline principle is obtained in India from the oil expressed from the seeds of *Carum Ajowan*. The Chinese peppermint plant has been recommended for cultivation in England, and especially in Ireland, where the climate is moist and labour cheap.

Myrtus chekon.—An evergreen climber belonging to the natural order Myrtaceæ, and native of Chili, where it is known as CHEQUEN, and is in great repute as a medicine in inflammation of the eyes, in diarrhœa, and other disorders, for which purposes

it was introduced into this country in 1881. Though the plant has been cultivated in our greenhouses for many years, it flowered for the first time at Kew in 1866.

Paullinia sorbilis.—A woody climber belonging to the natural order Sapindaceæ, and native of the Northern and Western parts of Brazil. The seeds, which are like small horse-chestnuts, are used in Brazil in the preparation of a beverage and as a medicine. To prepare them the seeds are dried, powdered, mixed with water, and kneaded into a kind of dough, then made into rolls, or moulded into various forms, and known as GUARANA, GUARANA BREAD, or BRAZILIAN COCOA. It is regarded as a tonic febrifuge, nutritive, and to some extent narcotic. As a nervous stimulant, it is analogous to tea and coffee, and has been recommended in this country in nervous headache, neuralgia, paralysis, and diarrhœa. It can be administered either in the form of a substance, as a beverage, or mixed with cocoa or chocolate. It was introduced to notice in this country firstly in 1856, and again in 1870.

Peumus Boldus.—A shrub 10 to 20 feet high, native of Chili, and cultivated in gardens in its native country for the sake of its fragrant flowers and leaves. The plant flowers in its native home in autumn, but under cultivation at Kew and the Royal Botanical Society's Gardens, Regent's Park, the flowers have appeared in winter. The plant belongs to the natural order Monimiaceæ, and the leaves under the name of BOLDO were introduced to this country in 1874, as an aid to digestion as well as in diseases of the liver. The properties of the plant are said to have been discovered by noticing the beneficial effects upon a flock of sheep that were suffering from liver disease, having been shut up in a fold which had been recently repaired with the twigs of the Boldo plant, the sheep having eaten of the leaves and shoots, and recovered very speedily. The leaves dried and pulverised are used in Brazil as a sternutatory.

Physostigma venenosum.—A perennial climbing plant with a woody stem fifty or more feet high, belonging to the natural order Leguminosæ, and found near the mouths of the Niger and Old Calabar River. The seeds are known under the names of ORDEAL BEANS OF OLD CALABAR, or CALABAR BEANS, and they were first brought to notice in England about the year 1840 by Dr. W. F. Daniell, who in 1846 brought them more prominently forward in a paper read before the Ethnological Society. The poisonous effects of the beans on the human system were noticed by Christison in 1855, and again by Sharpey in 1858. In 1859 a plant was sent by an African missionary to Professor Balfour, of Edinburgh, who described it under the name it now bears. It was not till about 1863 that Professor Fraser discovered that an alcoholic extract of the seed possessed the power of contracting the pupil of the eye, since which time it has been used in ophthalmic practice as well as in tetanus, rheumatic, neuralgic, and similar affections. The plants are somewhat rare in Africa, being destroyed by order of the Government, except so many as are required to supply seeds for use as an ordeal. They find their way, however, to this country in small quantities from West Africa.

Picramnia antidesma.—Under the name of CASCARA AMARGA the bark of this Mexican tree, which belongs to the natural order Simarubeæ, was first brought to notice in America in 1885, and soon after reached this country. It is said to be useful in syphilis, and as an external application in the treatment of erysipelas.

Pilocarpus pennatifolius.—This is a shrub four or five feet high, belonging to the order Rutaceæ, native of Brazil, and was first found in the southern provinces of Mato Grosso and São Paulo, from whence it was introduced into Europe in 1874, and is now found cultivated in the English and Continental botanical gardens. Under the name of JABORANDI a new drug was introduced to the notice of British pharmacists in 1874. Jaborandi, however, appears to be a comprehensive name in South America, and is applied to a number of widely different plants. The determination of the source of the ordinary Jaborandi of commerce was made by Professor Baillon in 1875, who, from the material available, considered that to the plant mentioned at the head of this paragraph must be referred the bulk of commercial Jaborandi, a quantity also being afforded by *P. Selloanus*, and probably other plants. Jaborandi has obtained a reputation as a very energetic diaphoretic sialagogue.

Piper methysticum.—The roots of this plant, which belongs to the natural order Piperaceæ, have been used from an early period in the Society and South Sea Islands under the name of KAVA in the preparation of a well known intoxicating beverage. In 1876 the plant began to attract some attention as to its medical properties, since which time many experiments have been made to determine its physiological action. It has since been used in practice in urethritis, leucorrhœa, dysuria, and all inflammatory conditions of the urinary passages. In the Colonial and Indian Exhibition, 1886, a spirit was sold at the refreshment bars under the name of Kava Schnapps or YANGONA, which was distilled from the roots of the Kava plant.

Plantago ovata.—An annual belonging to the

preparation of a powerful antisyphilitic, purgative, and diuretic medicine. It was introduced to notice in this country from North America in 1883.

Frankenia grandifolia.—An herbaceous plant of California. Under the name of YERBA REUMA it was introduced in 1879 as a remedy in catarrh, mucous discharges, and in ophthalmia.

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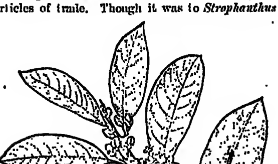
14th, 1885. The publication of this paper naturally resulted in the attention of the whole medical profession being drawn to this new and important drug, and consequently there arose a very great demand for it—a demand, indeed, far exceeding the supply. Immature fruits containing unripened seeds, and consequently less powerful in action, arrived in the market together with the seeds of other species than *S. hispidus*, the result being that the tincture prepared from them could not be relied upon. Of late, however, a better system of collecting seems to have been established, and tincture and tabloids of *Strophanthus* are now advertised as regular articles of trade. Though it was to *Strophanthus*



SPRIG OF THE COCA PLANT.

hispidus that the credit was first given as possessing the valuable cardiac properties, *S. kombe* has since shared its reputation; indeed, the two species are so closely allied, that Professor Oliver, who is the author of the latter, is now inclined to consider them identical. In Central Africa, the seeds when ground, mixed with water, and made into a paste, are used for poisoning arrows, both for purposes of the chase and in war.

Strychnos toxifera.—This plant is well known as furnishing the CURARE or WOURALI poison of British Guiana, which is prepared by scraping the bark, steeping it in water, and concentrating the fluid by evaporation. The natives use it for tipping their arrows in hunting as well as in war. It was brought to notice in this country in 1878 as a remedy in epilepsy, chorea, and hydrophobia, and is still included in our druggists' price lists.

Turnera diffusa var. *aphrodisiaca.*—This plant belongs to a small order Turneraceæ. A fluid extract of the plant was introduced to English pharmacy in 1874, under the name of DAMIANA, and recommended in renal and vesical diseases and in nephritic albumina. In some reports of its effects it is described as being "one of the best remedies in inflammatory diseases of the kidneys;" and taken as an infusion in the form of tea, prepared by pouring a cupful of hot water upon a teaspoonful of the dried leaves, it is said to have a marked effect upon sick headache.

FRENCH.—XX.

[Continued from p. 58.]

IRREGULAR ADJECTIVES.

THE following adjectives form their feminine irregularly:—

Masculine.	*Feminine.*
aigu, *sharp.*	aiguë.
ambigu, *ambiguous.*	ambiguë.
bénin, *benign.*	bénigne.
blanc, *white.*	blanche.
caduc, *decrepit, infirm.*	caduque.
coi, *quiet.*	coite.
épais, *thick.*	épaisse.
exigu, *scanty.*	exigue.
exprès, *express.*	expresse.
favori, *favourite.*	favorite.
frais, *fresh.*	fraîche.
franc, *free, frank.*	franche.
franc, *Frank, Frankish*	franque.
gentil, *pretty, genteel.*	gentille.
grec, *Grecian, Greek.*	grecque,
hébreu, *Hebrew.*	hébraïque, used only of the Hebrew tongue
jumeau, *twin.*	jumelle.
long, *long, slow.*	longue.
malin, *cunning, malignant*	maligne.
nul, *null, no.*	nulle.
oblong, *oblong.*	oblongue.
public, *public.*	publique.
sec, *dry, barren.*	sèche.
tiers, *third.*	tierce
turc, *Turkish.*	turque.

The following compound adjectives alter only their last component:—

Masculine.	*Feminine.*
aigre-doux, *sourish.*	aigre-douce.
mort-né, *still-born.*	mort-née.

Note.—The plural masculine of **aigre-doux**, *sourish*, is *aigres-doux*; its plural feminine is *aigres-douces*. The plural masculine of **mort-né**, *still-born*, is *mort-nés*; its plural feminine is *mort-nées*.

The following have no feminine:—

châtain, *chestnut colour, auburn.* dispos, *active.*

FORMATION OF THE PLURAL OF ADJECTIVES.

General Rule.—The plural of adjectives is formed by the addition of *s* to the masculine, or to the feminine termination:—

Masculine.		*Feminine.*	
Singular.	*Plural.*	*Singular.*	*Plural.*
grand, *great.*	grands.	grande.	grandes.
petit, *small.*	petits.	petite.	petites.

This rule has no exceptions with regard to the feminine termination.

With regard to the masculine termination, it is subject to the three following exceptions:—

First Exception.—Adjectives ending in the singular with *s* or *x* do not change their form in the plural:—

Singular.	*Plural.*
bas, *low.*	bas.
doux, *sweet, soft.*	doux.

Second Exception.—Adjectives having in the singular the termination *-eau*, form their plural masculine by the addition of *x*:—

Singular.	*Plural.*
beau, *handsome, beautiful.*	beaux.
jumeau, *twin.*	jumeaux.
nouveau, *new.*	nouveaux.

The adjectives *fou*, *mou*, *feu*, and *bleu* form their plural, according to the general rule, by adding *s*: *fous*, *mous*, *feus*, *bleus*.

Third Exception.—Adjectives ending in *-al* form their plural masculine by changing *-al* into *-aux*:—

Singular.	*Plural.*
libéral, *liberal.*	libéraux.
national, *national.*	nationaux.
rural, *rural.*	ruraux.

The following adjectives form their plural regularly; but they are hardly ever used in the masculine plural:—

Singular.	*Plural.*
bancal, *bandy-legged.*	bancals.
fatal, *fatal.*	fatals.
final, *final.*	finals.
matinal, *early.*	matinals.
médial, *medial.*	médials.
pénal, *penal.*	pénals.
théatral, *theatrical.*	théatrals.

Agreement of Adjectives with Nouns.

The adjective must agree, in gender and number, with the noun or pronoun which it qualifies:—

Masculine.

Singular.	*Plural.*
le *beau* jardin,	les *beaux* jardins.
the fine garden,	*the fine gardens.*
le *grand* livre,	les *grands* livres.
the large book,	*the large books.*

Feminine.

la *belle* maison,	les *belles* maisons.
the fine house,	*the fine houses.*
la *grande* carte,	les *grandes* cartes.
the large map,	*the large maps.*

This agreement must take place, not only when the adjective immediately precedes or follows the noun or pronoun, but also when it is separated by other words:—

Masculine.

Singular.—Plaise à Dieu de te rendre assez *bon* pour mériter la vie heureuse! FÉNELON.

May God render thee sufficiently good to deserve the blessed life!

Plural.—Jamais, en quoi que ce puisse être les méchants ne sont *bons* à rien de bon. J. J. ROUSSEAU.

The wicked are never, in any circumstances, fitted (good) to perform anything good.

Feminine.

Singular. — L'honneur de passer pour *bonne* l'empêchait de se montrer *mauvaise*. MARIVAUX.

The honour of passing for good prevented her showing herself bad.

Plural.—Loin de nous raidir contre les inclinations qui sont *bonnes*, il faut les suivre pour servir Dieu. MME. DE MAINTENON.

Far from resisting our good inclinations, we should follow them in order to serve God.

When an adjective relates to two or more substantives, whether in the singular or the plural, and all of the same gender, it must agree with the nouns in gender, and be put in the plural:—

Le riche et l'indigent, l'imprudent, et le sage, *sujets* à même loi, subissent même sort. J. B. ROUSSEAU.

The rich and the poor, the imprudent and the wise, being subject to the same law, experience the same fate.

When the words which the adjective qualifies are of different genders, the adjective must be put in the masculine plural:—

Je tâche de rendre *heureux*, ma femme, mon enfant, et même mon chat et mon chien. BERNARDIN DE ST. PIERRE.

I try to render happy my wife, my child, and even my cat and my dog.

L'ordre et l'utilité *publics* ne peuvent être le fruit du crime. MASSILLON.

Public order and utility cannot be the fruits of crime.

Determinative Adjectives.

There are three sorts of determinative adjectives—the demonstrative, the possessive, and the numeral.

Demonstrative Adjectives.

The demonstrative adjectives are used when an object is to be particularly specified or pointed out. They are never, in French, used substantively, that is, without the nouns which they determine:—

Singular.

Masculine.—**Ce**, *this* or *that*, used *before a word commencing with a consonant.*

Cet, *this* or *that*, used *before a word commencing with a vowel or an* h *mute.*

Feminine.—**Cette**, *this* or *that.*

Plural.

Ces, *these* or *those for both genders.*

Examples.

Masculine singular.	*Feminine singular.*
Ce soldat, *this or that soldier.*	Cette femme, *this or that woman.*
Cet ami, *this or that friend.*	Cette épee, *this or that sword.*
Cet homme, *this or that man.*	Cette harpe, *this or that harp.*

Plural.

Ces hommes, *these or those men.*	Ces femmes, *these or those women.*

Voyez *ce* papillon échappé du tombeau; Sa mort fut un sommeil, et sa tombe un berceau. DELILLE.

See that butterfly escaped from the tomb; his death was a slumber, and his tomb a cradle.

. . . . *Cet* admirable don, L'instinct, sans doute est loin de l'auguste raison. (THE SAME.)

That admirable gift, instinct, is doubtless far beneath majestic reason.

Là, *cette* jeune plante en vase disposée, Dans sa coupe élégante accueille la rosée. (THE SAME.)

There that young plant, shaped as a vase, receives the dew in its elegant cup.

Ces honneurs que le vulgaire admire, Réveillent-ils les morts au sein des monuments? SOUIEL.

Do those honours admired by the vulgar awake the dead from their sepulchres?

When it is necessary to make in French a difference similar to that existing between the English words *this* and *that*, the adverbs *ci* and *là* must be placed after the nouns:—

Ce livre-ci, *this book* (here).	Ce livre-là, *that book* (there).
Ces livres-ci, *these books*.	Ces livres-là, *those books*.

Possessive Adjectives.

The possessive adjectives, which are always joined to a noun, express possession; they are:—

Singular.		*Plural.*	
Masculine.	*Feminine.*	*Both genders.*	
mon,	ma,	mes,	*my.*
ton,	ta,	tes,	*thy.*
son,	sa,	ses,	*his, her, its.*
notre,	notre,	nos,	*our.*
votre,	votre,	vos,	*your.*
leur,	leur,	leurs,	*their.*

In French these adjectives take the gender and number of the object possessed, and not, as in English, those of the possessor:—

Masc. sing.	*Fem. sing.*	*Pl. both genders.*
Mon frère, *my brother.*	Ma sœur, *my sister.*	Mes cousins, *my cousins.*
Ton livre, *thy book.*	Ta plume, *thy pen.*	Tes maisons, *thy houses.*
Son papier, *his or her paper.*	Sa table, *his or her table.*	Ses habits, *his or her clothes.*
Notre cheval, *our horse.*	Notre vache, *our cow.*	Nos prairies, *our meadows.*
Votre lit, *your bed.*	Votre chaise, *your chair.*	Vos crayons, *your pencils.*
Leur foin, *their hay.*	Leur paille, *their straw.*	Leurs fermes, *their farms.*

Sobriété dans toute chose, *Mon* ami, c'est l'art de jouir. Du Tremblay.	*Sobriety in all things is, my friend, the true enjoyment.*
Ma main de quelque fleur esquisse la peinture. Castel.	*My hand sketches the picture of some flower.*
Mes sens sont glacés d'effroi. J. B. Rousseau.	*My senses are frozen with fear.*
De *son* propre artifice on est souvent victime. Colin d'Harleville.	*One is often the victim of his own artifice.*
À *sa* vocation chaque être doit répondre. Fr. de Neufchateau.	*Every being should fulfil his vocation.*
Il faut de *ses* amis endurer quelque chose. Molière.	*We must bear something from our friends.*
Notre vie est une maison, Y mettre le feu c'est folie. Nivernais.	*Our life is a house; to set it on fire is folly.*
Vos mailles se rompront sous la charge pesante. Castel.	*Your meshes will break under the heavy burden.*
Leurs fleurs suivront mes pas, en recréant ma vue. (The same.)	*Their flowers will follow my steps, and please my sight.*

The adjectives **mon**, *my;* **ton**, *thy;* **son**, *his* or *her*, are used instead of **ma**, **ta**, **sa** before feminine words commencing with a vowel or an *h* mute, in order to prevent the meeting of two vowels; thus we say:—

Mon épée, *my sword.*
Ton épouse, *thy wife.*
Son armée, *his army.*

C'en est fait, *mon* heure est venue. Boileau.	*All is over, my hour is come.*

The possessive adjectives must be repeated before every noun:—

Mon frère, ma sœur, et mes cousins sont à Paris.	*My brother, sister, and cousins are at Paris.*

Numeral Adjectives.

There are two kinds of numeral adjectives: the cardinal and the ordinal.

(1) The cardinal numbers indicate simply the number or quantity, without any reference to order: as, **un**, *one;* **deux**, *two*, etc.

(2) The ordinal numbers mark the order or rank which persons and things occupy: as, **premier**, *first;* **second**, *second*, etc.

(1) *Cardinal Numbers.*		(2) *Ordinal Numbers.*	
un, *feminine* une,	1	premier, *feminine* première; unième,	1st.
deux,	2	deuxième; second, *f.* seconde,	2nd.
trois,	3	troisième,	3rd.
quatre,	4	quatrième,	4th.
cinq,	5	cinquième,	5th.
six,	6	sixième,	6th.
sept,	7	septième,	7th.
huit,	8	huitième,	8th.
neuf,	9	neuvième,	9th.
dix,	10	dixième,	10th.
onze,	11	onzième,	11th.
douze,	12	douzième,	12th.
treize,	13	treizième,	13th.
quatorze,	14	quatorzième,	14th.
quinze,	15	quinzième,	15th.
seize,	16	seizième,	16th.
dix-sept,	17	dix-septième,	17th.
dix-huit,	18	dix-huitième,	18th.
dix-neuf,	19	dix-neuvième,	19th.
vingt,	20	vingtième,	20th.
vingt et un,	21	vingt et unième,	21st.
vingt-deux, etc.	22	vingt-deuxième, etc.	22nd.
trente,	30	trentième,	30th.
trente et un,	31	trente et unième,	31st.
trente-deux, etc.	32	trente-deuxième, etc.	32nd.
quarante,	40	quarantième,	40th.
quarante et un,	41	quarante et unième,	41st.
quarante-deux, etc.	42	quarante-deuxième, etc.	42nd.
cinquante,	50	cinquantième,	50th.
cinquante et un,	51	cinquante et unième,	51st.
cinquante-deux, etc.	52	cinquante-deuxième, etc.	52nd.
soixante,	60	soixantième,	60th.
soixante-et-un,	61	soixante et unième,	61st.
soixante-deux, etc.	62	soixante-deuxième, etc.	62nd.
soixante-dix,	70	soixante-dixième,	70th.
soixante et onze,	71	soixante et onzième,	71st.
soixante-douze,	72	soixante-douzième,	72nd.
soixante-treize,	73	soixante-treizième,	73rd.
soixante-quatorze,	74	soixante-quatorzième,	74th.
soixante-quinze,	75	soixante-quinzième,	75th.
soixante-seize,	76	soixante-seizième,	76th.
soixante-dix-sept,	77	soixante-dix-septième,	77th.
soixante-dix-huit,	78	soixante-dix-huitième,	78th.
soixante-dix neuf,	79	soixante-dix-neuvième,	79th.
quatre-vingts,	80	quatre-vingtième,	80th.
quatre-vingt-un,	81	quatre-vingt-unième,	81st.
quatre-vingt-deux, etc.	82	quatre-vingt-deuxième, etc.	82nd.
quatre-vingt-dix,	90	quatre-vingt-dixième,	90th.
quatre-vingt-onze,	91	quatre-vingt-onzième,	91st.
quatre-vingt-douze, etc.	92	quatre-vingt-douzième, etc.	92nd.
cent,	100	centième,	100th.
cent un, etc.	101	cent unième,	101st.
deux cents,	200	deux centième,	200th.
deux cent un, etc.	201	deux cent unième, etc.	201st.
trois cents,	300	trois centième,	300th.
trois cent un, etc.	301	trois cent unième, etc.	301st.
mille,	1000	millième,	1000th.
deux mille,	2000	deux millième,	2000th.
deux mille cinquante,	2050	deux mille cinquantième,	2050th.
un million,	1,000,000	millionième	1,000,000th.

zéro—0.

Variations of the Cardinal Numbers.

The following cardinal numbers vary:—

Un, *one*, takes the gender of the noun to which it is prefixed:—

un livre, *one book*; une feuille, *one leaf*.

When used substantively, *un* may take the mark of the plural:—

Masc.	Les uns et les autres.	*These and those.*
Fem.	Les unes et les autres.	(*The ones and the others*).

Vingt and *cent*, when preceded and multiplied by a number, and not followed by another, take the mark of the plural:—

quatre-*vingts*, *eighty*;	six *cents*, *six hundred*.
L'homme vit *quatre-vingts* ans, le chien n'en vit que dix. BUFFON.	*Man lives eighty years, the dog only ten.*
On m'apporta chez moi, douze *cents* francs. J. J. ROUSSEAU.	*They brought me, at my house, twelve hundred francs.*

Vingt and *cent*, however, when preceded and multiplied by a number, and followed by another, and used to indicate a date of the Christian era, do not take the mark of the plural:—

quatre-*vingt*-cinq hommes, cinq *cent* deux hommes,	*eighty-five men. five hundred and two men.*
Charlemagne fut proclamé empereur d'Occident, le jour de Noël, eu huit *cent*. VOLTAIRE.	*Charlemagne was proclaimed emperor of the West, Christmas-day, in the year eight hundred.*

Mille (*thousand*). For the date of the year of the Christian era the form *mil* alone is used:—

L'an **mil** huit cent cinquante.	*The year one thousand eight hundred and fifty.*

With regard to the years which have *preceded* the Christian era, and those which will *follow its first thousand*, the form *mille* is employed:—

La première irruption des Gaulois, eut lieu sous le règne de Tarquin, environ l'an du monde trois *mille* quatre cent seize. VERTOT.	*The first irruption of the Gauls took place under the reign of Tarquin, about the year of the world 3416.*

Million, *billion*, etc., take the mark of the plural.

Miscellaneous Observations on the Cardinal Numbers.

In French, in computing from twenty to thirty, thirty to forty, etc., the larger number must always precede the smaller. We may not say, as is often done in English, *one* and *twenty*, but always *vingt et un*, *vingt-deux*, etc.

The conjunction et is only used in the following numbers: — ***vingt et un*** (1), ***trente et un*** (31), ***quarante et un*** (41), ***cinquante et un*** (51), ***soixante et un*** (61), and ***soixante et onze*** (71).

With the exception of the six numbers mentioned above, the various components of compound numbers are connected by hyphens from ***dix-sept*** (17) to ***quatre-vingt-dix-neuf*** (99).

The word *one*, which frequently precedes in English the words ***hundred*** and ***thousand***, must not be rendered in French. We say:—

mille hommes,	*one thousand men.*
cent francs,	*one hundred francs.*

When the words *cent* and *mille* are used substantively before the name of objects generally reckoned or sold by the hundred or thousand, in number or in weight, the word *un* may be placed before them; the name of the object being preceded by the preposition *de*:—

Un cent, un mille de briques.
One hundred, one thousand (of) bricks.
Un cent (ou quintal) de sucre.
One hundred (weight) of sugar.

The words septante, *seventy*; octante, *eighty*; and nonante, *ninety*, are now nearly obsolete, being used only in the southern provinces of France. They are, as may be seen in the preceding table, replaced by the expressions: **soixante-dix**, *sixty-ten*; **quatre-vingts**, *four twenties* (four score); **quatre-vingt-dix**, *four-score-ten*, etc.

Before the word **onze**, *eleven*, and **onzième**, *eleventh*, neither the article nor any other word is elided. We say *le onze*, *le onzième*, *la onzième*. In pronunciation, the *s* of the plural article **les** is silent when the article precedes *onze* or *onzième*.

Observations on the Ordinal Numbers.

It will be seen that the ordinal numbers, with the exception of ***premier*** and ***second***, are formed from the cardinal by adding *-ième* to the latter.

When the cardinal ends in *e*, that *e* is suppressed: *quatre*, *quatrième*; when the cardinal ends in *q*, *u* is inserted between it and the ending of the ordinal: *cinq*, *cinquième*; when the cardinal ends in *f*, that *f* is changed into *v*: *neuf*, *neuvième*; and, finally, when the cardinal ends with any other consonant, *-ième* is added to it without any other change: *dix*, *dixième*.

All ordinal adjectives, except ***unième***, may take the mark of the plural.

Premier and ***second*** alone vary for the feminine, which is formed regularly by adding *e*: *première*, *seconde*.

Unième (*first*) is only used in composition with *vingt*, *trente*, *quarante*, *cinquante*, *soixante*, *quatre-vingt*, *cent*, and *mille*.

Deuxième is used in composition with the same numbers as *unième*, and also by itself. ***Second*** is only used by itself.

Hyphens are used in the same cases with ordinal as with cardinal adjectives.

The following words, sometimes used substantively and sometimes adjectively, may be classed among ordinal adjectives:—

Trentenaire,		*of thirty years' duration.*
Quarantenaire,		*of forty* " "
Quinquagénaire,	*fifty years old,*	*of fifty* " "
Sexagénaire,	*sexagenarian,*	*of sixty* " "
Septuagénaire,	*septuagenarian,*	*of seventy* " "
Octogénaire,	*octogenarian,*	*of eighty* " "
Nonagénaire,	*nonagenarian,*	*of ninety* " "
Centenaire,	*centenarian,*	*of one hundred* "

Quadragénaire, *a person forty years old,* is a noun.

Trentenaire and *quarantenaire* are law terms:—

Possession trentenaire, quarantenaire.	*Thirty, forty years' possession.*

Quarantenaire is also used in reference to *quarantine.*

The following—*quadragénaire, quinquagénaire, sexagénaire, septuagénaire, octogénaire, nonagénaire,* and *centenaire*—are applied to persons.

Un octogénaire plaintait, etc. LA FONTAINE.	*A man eighty years old was planting trees.*

RULES ON THE USE OF THE NUMERAL ADJECTIVES.

In speaking of the days of the month, the French use the cardinal, not the ordinal numbers, except, however, for the first, which is expressed by *premier*:—

le *premier* juin,	*the first of June.*
le *deux* mars,	*the second of March.*
le *dix-sept* avril,	*the seventeenth of April.*

L'ouverture des États-généraux eut lieu le *cinq* mai, 1789. THIERS.	*The opening of the States-general took place on the fifth of May, 1789.*

The cardinal numbers are also employed in speaking of sovereigns and princes, except the first, which is expressed by premier without article:—

Henri *premier,*	*Henry the First.*
Charles *dix,*	*Charles the Tenth.*
Louis *dix-huit,*	*Lewis the Eighteenth.*

Louis *onze* avait trente-huit ans, quand il monta sur le trône. ANQUETIL.	*Lewis the Eleventh was thirty-eight years old when he ascended the throne.*
La mort de Grégoire *sept* n'éteignit pas le feu qu'il avait allumé. VOLTAIRE.	*The death of Gregory the Seventh did not extinguish the fire which he had kindled.*

In speaking of Charles the Fifth, Emperor of Germany and King of Spain, and of the Pope Sixtus the Fifth, the word quint, *fifth,* is used:—

Charles-*quint,*	*Charles the Fifth.*
Sixte-*quint,*	*Sixtus the Fifth.*

NUMERAL NOUNS.

The numeral nouns in use in French are:—

unité,	*unit.*	trentaine,	*thirty.*
couple, paire,	*couple, pair.*	quarantaine,	*two score.*
trio,	*trio, three.*	cinquantaine,	*fifty.*
demi-douzaine,	*half-dozen.*	soixantaine,	*sixty.*
huitaine,	*eight days.*	une centaine,	*a hundred.*
neuvaine,	*nine (nine days of prayer).*	deux centaines,	*two hundred.*
		etc.	
dizaine,	*ten, half a score.*	un millier,	*one thousand.*
douzaine,	*dozen*	deux milliers,	*two thousand.*
quinzaine,	*fifteen, fortnight.*	une myriade,	*a myriad.*
		un million,	*a million.*
vingtaine,	*score, twenty.*		

The termination *aine,* when added to words of number, is equivalent to the English *some,* in cases like the following:—I have *some* twenty books (*i.e.,* about twenty books), *J'ai une* vingtaine *de livres.*

FRACTIONAL NUMERALS.

un quart,	*one quarter.*	deux cinquièmes,	*two fifths.*
trois quarts,	*three quarters.*		
le tiers,	*the third.*	un sixième, etc.	*one sixth, etc.*
deux tiers,	*two thirds.*	un dixième, etc.	*one tenth, etc.*
la moitié,	*the half.*	un centième,	*one hundredth.*
un cinquième,	*one fifth.*	un millième,	*one thousandth.*

It will be seen that, with the exception of *tiers, quart,* and *moitié,* these numbers are nothing but the ordinal adjectives. They may, therefore, take the mark of the plural when necessary.

The word *demi,* when used adjectively and preceding the noun, is invariable, and is joined to it by a hyphen:—

une *demi*-heure (f.),	*half an hour.*
une *demi*-livre (f.),	*half a pound.*

When coming after the noun to denote an *additional* half, it agrees in gender with the noun:—

une heure et *demie,*	*one hour and a half.*
une livre et *demie,*	*one pound and a half.*

When used substantively, *demi* may take the form of the plural:—

Cette horloge sonne les heures et les *demies.*	*This clock strikes the hours and the half-hours.*

ORDINAL ADVERBS.

Ordinal adverbs are formed from ordinal adjectives by adding *-ment* to the latter: *premièrement* and *secondement* being formed from *première* and *seconde,* the feminine of *premier* and *second*:—

premièrement, unièmement,	*first; in the first place.*	neuvièmement,	*ninthly.*
		dix-septièmement,	*seventeenthly.*
deuxièmement, secondement,	*secondly.*	vingtièmement,	*twentieth.*
		vingt et unièmement,	*twenty-first.*
troisièmement,	*thirdly.*		
quatrièmement,	*fourthly.*	vingt deuxièmement,	*twenty-second*
cinquièmement,	*fifthly.*		
sixièmement,	*sixthly.*	*etc.*	*etc.*

Premièrement is only used by itself; *unièmement* is only employed in composition with *vingt, trente, quarante,* etc. *Secondement* is only used by itself; but *deuxièmement* is used both by itself and in composition with *vingt, trente,* etc.

Hyphens are employed with ordinal adverbs in the same cases as with numeral adjectives.

Instead of the adverbs mentioned above, the Latin form, *primo, secundo, tertio, quarto,* etc.. is also frequently used.

TRANSLATION FROM FRENCH.

Blaise Pascal, the author of the celebrated "Pensées," was born at Clermont-Ferrand on the 19th of June, 1623. He was educated by his father, a man of extraordinary intellectual activity. From his boyhood, Blaise Pascal overtaxed his

Variations of the Cardinal Numbers.

The following cardinal numbers vary:—

Un, *one*, takes the gender of the noun to which it is prefixed:—

un livre, *one book;* **une** feuille, *one leaf.*

When used substantively, *un* may take the mark of the plural:—

Masc.	Les *uns* et les autres.	*These and those.*
Fem.	Les *unes* et les autres.	(*The ones and the others*).

Vingt and *cent*, when preceded and multiplied by a number, and not followed by another, take the mark of the plural:—

quatre-*vingts*, *eighty;*	six *cents*, *six hundred.*
L'homme vit *quatre-vingts* ans, le chien n'en vit que dix. BUFFON.	*Man lives eighty years, the dog only ten.*
On m'apporta chez moi, douze *cents* francs. J. J. ROUSSEAU.	*They brought me, at my house, twelve hundred francs.*

Vingt and *cent*, however, when preceded and multiplied by a number, and followed by another, and used to indicate a date of the Christian era, do not take the mark of the plural:—

quatre-*vingt*-cinq hommes,	*eighty-five men.*
cinq *cent* deux hommes,	*five hundred and two men.*
Charlemagne fut proclamé empereur d'Occident, le jour de Noël, en huit *cent.* VOLTAIRE.	*Charlemagne was proclaimed emperor of the West, Christmas-day, in the year eight hundred.*

Mille (*thousand*). For the date of the year of the Christian era the form *mil* alone is used:—

L'an **mil** huit cent cinquante.	*The year one thousand eight hundred and fifty.*

With regard to the years which have *preceded* the Christian era, and those which will *follow its first thousand*, the form *mille* is employed:—

La première irruption des Gaulois, eut lieu sous le règne de Tarquin, environ l'an du monde trois *mille* quatre cent seize. VERTOT.	*The first irruption of the Gauls took place under the reign of Tarquin, about the year of the world 3416.*

Million, *billion*, etc., take the mark of the plural.

Miscellaneous Observations on the Cardinal Numbers.

In French, in computing from twenty to thirty, thirty to forty, etc., the larger number must always precede the smaller. We may not say, as is often done in English, *one* and *twenty*, but always *vingt et un*, *vingt-deux*, etc.

The conjunction et is only used in the following numbers: — *vingt et un* (1), *trente et un* (31), *quarante et un* (41), *cinquante et un* (51), *soixante et un* (61), and *soixante et onze* (71).

With the exception of the six numbers mentioned above, the various components of compound numbers are connected by hyphens from *dix-sept* (17) to *quatre-vingt-dix-neuf* (99).

The word *one*, which frequently precedes in English the words *hundred* and *thousand*, must not be rendered in French. We say:—

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When the words *cent* and *mille* are used substantively before the name of objects generally reckoned or sold by the hundred or thousand, in number or in weight, the word *un* may be placed before them; the name of the object being preceded by the preposition *de*:—

Un cent, un mille de briques.
One hundred, one thousand (of) bricks.
Un cent (un quintal) de sucre.
One hundred (weight) of sugar.

The words **septante**, *seventy;* **octante**, *eighty;* and **nonante**, *ninety*, are now nearly obsolete, being used only in the southern provinces of France. They are, as may be seen in the preceding table, replaced by the expressions: **soixante-dix**, *sixty-ten;* **quatre-vingts**, *four twenties* (four score); **quatre-vingt-dix**, *four-score-ten*, etc.

Before the word **onze**, *eleven*, and **onzième**, *eleventh*, neither the article nor any other word is elided. We say *le onze*, *le onzième*, *la onzième.* In pronunciation, the *s* of the plural article **les** is silent when the article precedes *onze* or *onzième.*

Observations on the Ordinal Numbers.

It will be seen that the ordinal numbers, with the exception of *premier* and *second*, are formed from the cardinal by adding *-ième* to the latter.

When the cardinal ends in *e*, that *e* is suppressed: *quatre*, *quatrième;* when the cardinal ends in *q*, *u* is inserted between it and the ending of the ordinal: *cinq*, *cinquième;* when the cardinal ends in *f*, that *f* is changed into *v: neuf*, *neuvième;* and, finally, when the cardinal ends with any other consonant, *-ième* is added to it without any other change: *dix*, *dixième.*

All ordinal adjectives, except *unième*, may take the mark of the plural.

Premier and *second* alone vary for the feminine, which is formed regularly by adding *e: première*, *seconde.*

Unième (*first*) is only used in composition with *vingt*, *trente*, *quarante*, *cinquante*, *soixante*, *quatre-vingt*, *cent*, and *mille.*

Deuxième is used in composition with the same numbers as *unième*, and also by itself. *Second* is only used by itself.

Hyphens are used in the same cases with ordinal as with cardinal adjectives.

The following words, sometimes used substantively and sometimes adjectively, may be classed among ordinal adjectives:—

Trentenaire,		*of thirty years' duration.*	
Quarantenaire,		*of forty*	,, ,,
Quinquagénaire,	*fifty years old,*	*of fifty*	,, ,,
Sexagénaire,	*sexagenarian,*	*of sixty*	,, ,,
Septuagénaire,	*septuagenarian,*	*of seventy*	,, ,,
Octogénaire,	*octogenarian,*	*of eighty*	,, ,,
Nonagénaire,	*nonagenarian,*	*of ninety*	,, ,,
Centenaire,	*centenarian,*	*of one hundred*	,,

Quadragénaire, *a person forty years old*, is a noun.

Trentenaire and *quarantenaire* are law terms :—

Possession trentenaire, quarantenaire.	*Thirty, forty years' possession.*

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Un octogénaire plaintait, etc. LA FONTAINE.	*A man eighty years old was planting trees.*

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Louis *onze* avait trente-huit ans, quand il monta sur le trône. ANQUETIL.	*Lewis the Eleventh was thirty-eight years old when he ascended the throne.*
La mort de Grégoire *sept* n'éteignit pas le feu qu'il avait allumé. VOLTAIRE.	*The death of Gregory the Seventh did not extinguish the fire which he had kindled.*

In speaking of Charles the Fifth, Emperor of Germany and King of Spain, and of the Pope Sixtus the Fifth, the word quint, *fifth,* is used :—

Charles-*quint,*	*Charles the Fifth.*
Sixte-*quint,*	*Sixtus the Fifth.*

NUMERAL NOUNS.

The numeral nouns in use in French are :—

unité,	*unit.*	trentaine,	*thirty.*
couple, paire,	*couple, pair.*	quarantaine,	*two score.*
trio,	*trio, three.*	cinquantaine,	*fifty.*
demi-douzaine,	*half-dozen.*	soixantaine,	*sixty.*
huitaine,	*eight days.*	une centaine,	*a hundred.*
neuvaine,	*nine (nine days of prayer).*	deux centaines,	*two hundred.*
		etc.	
dizaine,	*ten, half a score.*	un millier,	*one thousand.*
douzaine,	*dozen*	deux milliers,	*two thousand.*
quinzaine,	*fifteen, fortnight.*	une myriade,	*a myriad.*
		un million,	*a million.*
vingtaine,	*score, twenty.*		

The termination *aine,* when added to words of number, is equivalent to the English *some,* in cases like the following :—I have *some* twenty books (*i.e.,* about twenty books), *J'ai une* vingtaine *de livres.*

FRACTIONAL NUMERALS.

un quart,	*one quarter.*	deux cinquièmes,	*two fifths.*
trois quarts,	*three quarters.*		
le tiers,	*the third.*	un sixième, etc.	*one sixth, etc.*
deux tiers,	*two thirds.*	un dixième, etc.	*one tenth, etc.*
la moitié,	*the half.*	un centième,	*one hundredth.*
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It will be seen that, with the exception of *tiers, quart,* and *moitié,* these numbers are nothing but the ordinal adjectives. They may, therefore, take the mark of the plural when necessary.

The word *demi,* when used adjectively and preceding the noun, is invariable, and is joined to it by a hyphen :—

une *demi*-heure (f.),	*half an hour.*
une *demi*-livre (f.),	*half a pound.*

When coming after the noun to denote an *additional* half, it agrees in gender with the noun :—

une heure et *demie,*	*one hour and a half.*
une livre et *demie,*	*one pound and a half.*

When used substantively, *demi* may take the form of the plural :—

Cette horloge sonne les heures et les *demies.*	*This clock strikes the hours and the half-hours.*

ORDINAL ADVERBS.

Ordinal adverbs are formed from ordinal adjectives by adding *-ment* to the latter : *premièrement* and *secondement* being formed from *première* and *seconde,* the feminine of *premier* and *second* :—

premièrement, uniémement,	*first; in the first place.*	neuvièmement,	*ninthly.*
		dix-septièmement,	*seventeenthly.*
deuxièmement, secondement,	*secondly.*	vingtièmement,	*twentieth.*
		vingt et unièmement,	*twenty-first.*
troisièmement,	*thirdly.*		
quatrièmement,	*fourthly.*	vingt deuxièmement,	*twenty-second*
cinquièmement,	*fifthly.*		
sixièmement,	*sixthly.*	*etc.*	*etc.*

Premièrement is only used by itself; *unièmement* is only employed in composition with *vingt, trente, quarante,* etc. *Secondement* is only used by itself; but *deuxièmement* is used both by itself and in composition with *vingt, trente,* etc.

Hyphens are employed with ordinal adverbs in the same cases as with numeral adjectives.

Instead of the adverbs mentioned above, the Latin form, *primo, secundo, tertio, quarto,* etc., is also frequently used.

TRANSLATION FROM FRENCH.

Blaise Pascal, the author of the celebrated "Pensées," was born at Clermont-Ferrand on the 19th of June, 1623. He was educated by his father, a man of extraordinary intellectual activity. From his boyhood, Blaise Pascal overtaxed his

Accounts numbered 1 and 2 are the Proprietors' accounts—*i.e.*, accounts of the Capital of the Business. In the present illustrations, the Capital accounts are made to show, amongst other things, the details of capital withdrawn by the partners during the period for which the books remained open. On the supposition that such withdrawals are not of frequent occurrence, and are intended to be permanent withdrawals, the Capital accounts very properly give such information. But if the partners are frequently paying in and drawing out portions of capital, as is sometimes the case, it is much better not to crowd numerous minor transactions of this kind into the ordinary Capital accounts, but to open an additional account for each partner. The additional account is called that partner's Private or Current account, and is closed, when the books are closed, by transferring the balance to his original account. This transfer is effected under a Journal entry, headed So-and-So (Capital account) dr. to So-and-So (Private account), or *vice versâ*, according to whether the balance to be transferred is a debit or a credit one. The fictitious interest which in many businesses is to be found booked on Capital moneys may be included in the Private account, if so preferred.

Dr. CASH. Cr. (3)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 1	To Sundries (Balance)	370	1,500	–	–	Jan. 31	By Sundries - -	371	1,407	18	11
„ 31	„ do. - - -	371	2,013	6	6	Feb. 28	„ do. - -	372	1,475	10	11
Feb. 28	„ do. - - -	371	70	2	1	Mch. 31	„ do. - -	62	169	17	3
Mch. 31	„ do. - - -	62	1,719	9	6	Ap. 30	„ do. - -	62	606	14	1
Ap. 30	„ do. - - -	62	232	6	9	May 31	„ do. - -	63	2,519	14	1
May 31	„ do. - - -	63	493	14	5	June 30	„ do. - -	63	441	8	2
Jun. 30	„ do. - - -	63	910	12	8	„ „	„ Balance - -	64	278	8	6
			6,939	11	11				6,939	11	11
July 1	To Balance - -		278	8	6						

Dr. PETTY CASH. Cr. (4)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 31	To Cash - -	371	20	–	–	Jan. 31	By Sundry Expenses	371	5	2	–
Ap. 30	„ do. - - -	62	10	–	–	Feb. 28	„ do.	372	4	18	–
Jun. 30	„ do. - - -	63	10	–	–	Mch. 31	„ do.	62	5	5	–
						Ap. 30	„ do.	62	4	15	–
						May 31	„ do.	63	5	10	2
						Jun. 30	„ do.	63	4	9	10
						„ „	„ Balance - -	64	10	–	–
			40	–	–				40	–	–
July 1	To Balance - -		10	–	–						

In the two accounts of Cash and Petty Cash given above are recorded in a summary form the whole of the Cash transactions. The former is really the Bank account, and, in the present case, includes all receipts and nearly all payments, small disbursements only being provided for out of Petty Cash. In a business in which the receipts and payments generally are of some magnitude, and mostly effected by means of bankers' cheques, this arrangement is a convenient and a safe one; but it is not so suitable for every retail business where the receipts and payments yield a numerous total of comparatively small sums. In such circumstances it is often desirable to keep three Cash accounts—one for Cash at the bank, a second for Cash (not cheques) received and paid on the

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Dr. ARTHUR STONE (CAPITAL). Cr. (1)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 24	To Cash - - -	234	50	–	–	Jan. 1	By Sundries (Bal.)	370	2,500	–	–
June 30	,, Balance - -	64	2,577	2	11	June 30	,, Interest - - -	63	61	8	–
						,, ,,	,, Profit and Loss	64	65	14	11
			2,627	2	11				2,627	2	11
						July 1	By Balance - -		2,577	2	11

Dr. CALEB WOOD (CAPITAL). Cr. (2)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 25	To Cash - - -	234	50	–	–	Jan. 1	By Sundries (Bal.)	370	2,500	–	–
June 30	,, Balance - -	64	2,577	3	2	June 30	,, Interest - - -	63	61	8	2
						,, ,,	,, Profit and Loss	64	65	15	–
			2,627	3	2				2,627	3	2
						July 1	By Balance - -		2,577	3	2

An account for landed or house property, and a kindred account for any mortgage on the same property, may be kept as two entirely distinct and separate accounts, and are, in fact, oftentimes so treated; but the above arrangement, in which the two are detailed in separate columns, but still kept together and made to yield one balance, is extremely convenient in practice. It has the advantage of presenting the value of the property both with and without the mortgage charge upon it; and it does not allow of this charge being lost sight of whenever the property is under consideration, and the Property account is referred to. It may be said that a man is not likely to forget the existence of his mortgages, and, if he have only one or two, we readily admit that he is not. But if there be many instead of a few, secured on properties situated in different parts of the country, or even in different parts of the world—as is the case with some trading establishments—then the desirability of dealing with the property and the mortgage in adjacent columns becomes manifest.

The next account represents the purchase of Government Stock. The nominal amount of such stock bought is often inserted in the description column, or in a column specially set apart for the purpose, and ruled, say, between the money columns on its right and the reference column on its left.

Dr. TWO-AND-THREE-QUARTERS % CONSOLIDATED STOCK. Cr. (8)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 31	To Cash - - -	371	990	–	–	Mch. 31	By Cash - -	62	1,001	5	–
Jun. 30	„ Profit and Loss -	63	11	5	–						
			1,001	5	–				1,001	5	–

Dr. DRAPERY GOODS. Cr. (9)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 31	To Sundries - -	370	1,358	15	–	Jan. 31	By Sundries - -	370	864	10	6
Mch. 31	„ do. - - -	62	513	10	–	Feb. 28	„ do. - -	371	311	13	3
Ap. 15	„ J. Leader (corrn.)	62	1	0	10	Mch. 31	„ do. - -	62	180	2	6
May 31	„ Sundries - -	63	310	8	4	Ap. 30	„ do. - -	62	95	1	9
June 30	„ do. - - -	63	185	12	11	Jun. 30	„ do. - -	63	78	16	11
„ „	„ Profit and Loss -	63	172	16	2	„ „	„ Balance - -	61	972	9	4
			2,542	3	3				2,542	3	3
July 1	To Balance - -		972	9	4						

Dr. TEA. Cr. (10)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 31	To Sundries - -	370	638	–	5	Jan. 31	By Sundries - -	370	184	2	10
„ „	„ Cash - - -	371	89	6	6	Feb. 28	„ do. - -	371	21	13	–
Ap. 30	„ Sundries - -	62	183	6	3	Mch. 31	„ do. - -	62	30	10	–
„ „	„ Cash - - -	62	30	–	–	Ap. 30	„ do. - -	62	78	14	–
May 31	„ Sundries - -	63	104	18	4	May 31	„ do. - -	63	213	8	7
„ „	„ Cash - - -	63	60	–	–	Jun. 30	„ Balance - -	61	587	1	10
Jun. 30	„ Profit and Loss -	63	13	4	9						
			1,118	16	3				1,118	16	3
July 1	To Balance - -		587	1	10						

Dr. LEATHER GOODS. Cr. (11)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 31	To Sundries - -	370	219	12	–	Feb. 28	By Sundries - -	371	40	4	–
Feb. 28	,, do. - - -	371	118	16	–	Mch. 31	,, do. - -	62	30	16	6
Ap. 30	,, do. - - -	62	123	6	–	Ap. 30	,, do. - -	62	20	14	–
Jun. 30	,, do. - - -	63	110	18	6	May 31	,, do. - -	63	18	8	3
,, ,,	,, Profit and Loss -	63	11	19	–	Jun. 30	,, do. - -	63	23	7	–
						,, ,,	,, Balance - -	64	451	1	9
			584	11	6				584	11	6
July 1	To Balance - -		451	1	9						

BOTANY.—X.

[*Continued from p. 40.*]

THE COROLLA (*continued*)—THE ANDRŒCIUM—THE GYNÆCEUM.

THE *campanulate*, or bell-shaped corolla, is wider, and is characteristic of the genus *Campanula*, including the harebell; the *urceolate*, or barrel-shaped, is constricted at the mouth, as in many heaths and allied plants; the *infundibuliform*, or funnel-shaped, is narrow at the base and widens outwards, as in the small *Convolvulus arvensis*, whilst the *trumpet-shaped*, as in *Calystegia sepium*, the large white convolvulus, differs in its reflexed margin; the *hypocrateriform*, or salver-shaped, has a long tube with the limb at right angles to it, like a gamopetalous modification of the caryophyllaceous type, as in the primrose; and the *rotate*, or wheel-shaped form, differs in having a short tube, bearing, that is to say, a similar relation to the rosaceous type, as in the elder, laurustinus, forget-me-not (*Myosotis*), or pimpernel (*Anagallis*). The chief monosymmetric gamopetalous forms are the bilabiate and the ligulate. The *bilabiate* or two-lipped corolla is either *ringent*, gaping, or *personate*, mask-shaped. In the ringent type, characteristic of the order *Labiatæ*, the two posterior petals are united throughout to form a hood, the three others forming a lip, *labellum*, or landing-place for insect visitants, all five uniting in a tube below, as in the sage or dead-nettle (Fig. 53). The honeysuckle (Fig. 54) is a modification of this form, the odd anterior petal alone forming a labellum and the other four being reflexed. The personate type, represented by the snapdragon (*Antirrhinum*) has its mouth closed by the "palate" of three anterior petals. In this genus the centre one of these three is pouched (*saccate*) at the base, whilst in the allied toad-flax (*Linaria*) it is spurred (*calcarate*). In the *ligulate*, or strap-shaped, corolla, characteristic of the outer or "ray" florets of some *Compositæ*, such as the daisy, or of all the florets in another sub-order, the *Liguliflorae*, such as the dandelion, there is a tube below, but in the limb region one or more of the posterior (inner) petals are undeveloped, so that the others form a flat strap with notches, indicating their number, at their apex. Besides these types reference may be here made to the *sub-campanulate* corolla of the fox-glove (*Digitalis*), and the *sub-rotate* one of *Veronica*, in which the two posterior petals of five are united into one broad one.

In texture there is considerable variety in corollas, from the thick fleshy petals of *Magnolia* or the water-lilies to the delicate ones of the rock-rose (*Helianthemum*) resembling tissue-paper.

With regard to the colour and markings, the most noticeable points are their connection with perfume, with season of flowering, and with the visits of insects, etc., and their limitations in certain groups of plants. Many white flowers, for instance, are sweet-scented, especially in the evening, when they are readily seen by moths; whilst many brownish flowers have a carrion scent attractive to flies. Among British plants blue flowers, on the average, open first, then white, purple, yellow, and lastly red; whilst it is said that in travelling from the equator to the poles first the red, then the blue, and then the yellow flowers diminish in number, leaving only the white. Of closely related plants some have a uniformly coloured corolla, as in the dwarf mallow (*Malva rotundifolia*), whilst others are variegated with lines or dots, as in the common mallow (*M. sylvestris*). In these cases the less conspicuous is generally self-fertilising, whilst the lines and dots, as in *Tropæolum* or *Dianthus*, serve as honey-guides for insects. Wasps seem partial to orange flowers and humming-birds to red.

Many weeds of world-wide distribution have small white flowers and are self-fertilising. Some natural orders and genera are restricted in their range of colour, the *Umbelliferæ*, for instance, being nearly all white or yellow-flowered, and the *Cruciferæ* the same, with a few red flowers, red and white predominating among *Caryophyllaceæ*, whilst true blues are comparatively rare, not occurring among the wide range of colour of roses, dahlias, or chrysanthemums. The colouring-matters in fact form two series: the *cyanic*, blue, violet, and red, generally in solution; and the *xanthic*, yellow, orange, and red, usually in chromoplastids, and the two series seldom occur in the same flower.

In duration the corolla may be *caducous*, as in the grape-vine, in which the petals cohere by their tips, falling off like a little star as the flower opens; *fugacious*, falling readily if gathered, as in the flaxes; *deciduous*, falling, as is generally the case, after the fertilisation; or *persistent* in a withered state, as in *Campanula*.

In æstivation, the folding of the individual petals is described as in the vernation of foliage leaves (Vol. III., p. 213); but in those of the poppy we have the exceptional degree of plication known as *crumpled*, and with reference to their collective arrangement we have the *vexillary* or *papilionaceous* type before mentioned as characteristic of the *Papilionaceæ*, the chief sub-order of *Leguminosæ*.

THE ANDRŒCIUM.

Passing to the outer group of the essential organs, which are known as *stamens*, or collectively as the *andrœcium* (Greek ἀνδρός, *andros*, man's; οἶκος, *oikos*, house), we find each staminal leaf or male sporophyll to consist typically of a stalk-like, usually thread-like, *filament* surmounted by an *anther*, usually two-lobed and two-chambered when ripe, containing the *pollen*, usually a fine powder, which is the active agent in fertilisation.

In its earliest stages, a stamen, like a sepal or a petal, closely resembles a foliage leaf, and the examination of double azaleas and other cases shows that it has no true petiolar region, filament and anther together corresponding to the lamina. There is generally a central bundle of spiral vessels, or midrib. As the stamen develops, certain cells in its interior give rise to the pollen-mother-cells, generally in four chambers or *pollen-sacs*, which afterwards merge into two (*bi-locular*); and the two outer layers of cells become specially modified, the outer into a slightly cuticularised epidermis or *exothecium*, the inner, or *endothecium*, into a layer of spirally thickened cells interrupted in the region at which the anther splits when ripe. The central portion of the stamen between the pollen-sacs is termed the *connective*. It is usually small; but in the violet it is produced into a triangular buff-tip, and in two of the stamens is also *appendiculate*, being furnished with a tail-like nectariferous appendage at the base of each, which is enclosed in the spur of the corolla. In heaths there are two similar processes, non-nectariferous, at the base of each anther. In the hornbeam the connective bifurcates, like the unijugate leaf of *Bauhinia*, each branch bearing an anther-lobe or *dimidiate* (*i.e.*, halved) anther, whilst in the sage (*Salvia*) the connective is a long, unequal-armed lever, with an anther-lobe at each end, the lower one abortive. When the connective is thus enlarged the anther is termed *distractile*. If the filament be absent, the anther is *sessile*; whilst if the more essential anther be absent, the stamen or filament is *abortive* or *sterile*, and is commonly termed a *staminode*.

The stamens may be described with reference to their (i.) number, (ii.) relative length, (iii.) union or cohesion, (iv.) insertion or adhesion, (v.) form of filament and anther and the mode of insertion of the latter on the former, and (vi.) mode of dehiscence of anther.

There may be but one stamen in a flower (*monandrous*), as in the spur-valerian (*Centranthus*), in *Arum* or in *Euphorbia*, in which latter cases the stamen constitutes an entire flower, achlamydeous and imperfect. The apparently jointed filament in the spurges (*Euphorbia*) is in fact a pedicel with a filament articulated near its apex, though really lateral. There are two stamens (*diandrous*) in *Veronica* and many willows; three (*triandrous*) in most grasses, in *Iris* and other monocotyledons; four (*tetrandrous*) in *Alchemilla*; five (*pentandrous*) in many dicotyledons; six (*hexandrous*) in lilies, rushes, and other monocotyledons; seven (*heptandrous*) very exceptionally, in the horse-chestnut; eight (*octandrous*) in heath (*Erica*); nine (*enneandrous*) in the flowering-rush (*Butomus*); ten (*decandrous*) in many dicotyledons; twelve (*dodecandrous*) in *Lythrum*. If there are more than twenty they are termed *indefinite*, as in *Ranunculus*, *Rosa*, or *Malva*.

Linné or Linnæus, the illustrious Swede to whom we owe our system of binomial nomenclature (Vol. II., p. 273) and much of the precision in the use of descriptive terms in botany, constructed in the last century the most convenient of all artificial systems of classification or indexes to the vegetable kingdom, primarily upon the stamens, their number, relative length and union, his first eleven classes being *Monandria*, *Diandria*, etc., as above.

The stamens are commonly equal in length; but sometimes of various lengths according to their order of development; and if they are in

more than one whorl, those of one whorl are often longer than those of another, as in *Lythrum*. Special names are given to two particular cases. In most *Labiatæ* and *Scrophulariaceæ*, the fifth (posterior) stamen of the single staminal whorl is suppressed and, of the four stamens that are developed, two grow longer than the other two. They are then termed *didynamous* (Greek δίς, *dis*, two; δύναμις, *dunamis*, strength). In the *Cruciferæ* there are two whorls of stamens with originally two stamens in each whorl; but the anterior and posterior stamens which form the inner whorl at an early stage of development bifurcate, each branch bearing a perfect bilocular anther. Two lateral nectariferous glands at the base of the ovary make the filaments of the lateral (outer) stamens curve outwards so that they appear shorter than the two paired inner ones, and the six—four long and two short—are, therefore, termed *tetradynamous*. (Fig. 55, C.) Linné's fourteenth and fifteenth classes were *Didynamia* and *Tetradynamia*. When the stamens all lie against one side of the flower, as in cacti, they are called *declinate*; when they are within the corolla-tube, as in the fox-glove (*Digitalis*), they are *included*, and when they project beyond it, as in Fuchsia, they are *exserted*.

The stamens may either be *free*, as in all the Linnæan classes as yet referred to, or they may be united by their filaments, by their anthers, or by both. Some of the cases of apparent union by the filaments are truly due to branching (chorisis). Intercalary growth of a zone of tissue below all the stamens carrying them up on a tube, as if all united by the lower part of their filaments, as in *Malva*, *Geranium*, *Ulex*, *Cytisus*, causes them to be termed *monadelphous*. (See p. 36.) In the pea and many other *Leguminosæ* only nine of the ten stamens are united by their filaments in this way, the upper (posterior) stamen being free. This arrangement is termed *diadelphous*. In St. John's-worts, oranges, etc., as we have seen, the stamens forming a single whorl branch repeatedly, so forming bundles of stamens, which are hence termed *polyadelphous*. Linné's sixteenth, seventeenth, and eighteenth classes were *Monadelphia*, *Diadelphia*, and *Polyadelphia*. In these cases of branching the branches often bear only half, *i.e.*, unilocular, anthers.

In the *Compositæ* the five stamens have their filaments free but become united by their anthers, which are then called *syngenesious* (Greek σύν, *sün*, together, γένεσις, *genesis*, production), this being a case of true subsequent cohesion. Linné's nineteenth class, *Syngenesia*, included all *Compositæ* and a few other plants. In the butcher's-broom (*Ruscus*) the six stamens have their filaments united into a tube and their anthers united alternately base to base or apex to apex so as to form a zigzag. In the cucumber family (*Cucurbitaceæ*) there are five stamens, but two pairs cohere so that there appear to be but three filaments, and all the anthers are commonly united into one *sinuous* mass.

The insertion or adhesion of the stamens can usually be described by the same terms as that of the corolla, viz., *hypogynous*, *perigynous*, or *epigynous* (see pp. 36, 38); but in gamopetalous (or gamophyllous) flowers, owing to intercalary growth beneath both the corolline and the staminal whorl, they often appear to spring from the corolla-tube (or perianth), and then are termed, in addition to being hypogynous or epigynous as the corolla may happen to be, *epipetalous* (or *epiphyllous*), as in *Primula*, lilac (*Syringa*), etc. Linné's twelfth and thirteenth classes were *Icosandria* (literally twenty stamens), with twenty or more perigynous stamens, as in most *Rosaceæ*, and *Polyandria* (literally many stamens), with twenty or more hypogynous stamens, as in poppies, *Ranunculaceæ*, etc. In orchids and a few other plants the stamens are adherent to the gynœceum, forming a column or *gynostemium*, and the flower is then termed *gynandrous*. Linné's twentieth class was *Gynandria*.

Though commonly thread-like or *filiform*, the filament is sometimes, as in grasses, so slender, hair-like, or *capillary* as to bend under the weight of the anther. In other cases it is broader at the base, tapering like an awl or *subulate*; or it may be broad and *petaloid*. (Fig. 55, D.)

The anther, though when mature commonly two-chambered or *bilocular*, may retain its four chambers, as in *Butomus*, being then *quadrilocular*, or may have only one chamber, as in *Malva* (*unilocular*). It varies considerably in form, being sometimes round; sometimes linear; sometimes, as we have seen, sinuous; and its lobes may be parallel, or, as in grasses, diverging at each end. Appendages may, as in the cranberry (*Vaccinium*) spring from the anther itself, or from the connective. Though usually yellow, it is violet in many grasses, black in poppies, and other colours.

The anther is sometimes attached to the filament, or to its direct continuation, the connective, throughout its whole length, as in water-lilies, violets, etc., when it is termed *dorsifixed* or *adnate*. In other cases it is articulated at its base to the apex of the filament, and is called *basifixed* or *innate*, as in sedges (*Carex*); or, again, it may be only attached by a point about the middle of its back so that it can turn freely as on a ball-and-socket joint, and is, therefore, called *versatile*, as in grasses and lilies. In *Salvia* the long connective is attached in this

way to a short stout filament, on which it swings like the ancient quintain.

To discharge its pollen when ripe, the anther generally splits or *dehisces longitudinally*, by a slit

Fig. 53.—White Dead-nettle (*Lamium album*).

down the face of each lobe, as in lilies, grasses, violets, etc. When short and rounded, it sometimes dehisces *transversely*, by a horizontal split, as in *Alchemilla*. In the heath family (*Ericaceæ*) dehiscence is *porous*, by a hole at the top of each lobe; the lobes in some genera, such as the cranberries (*Vaccinium*), being produced upward into tubular processes. (Fig: 55, A.) In the barberry (*Berberis*) and in the bay-tree (*Laurus*) dehiscence is *opercular* or *valvular*, two parallel splits and one transverse one on the face of each lobe forming a little door or *operculum* which folds back in an upward direction. Dehiscence is often an important classificatory character, and from this point of view we must observe not only the mode, but also the direction in which it takes place. In *Compositæ*, *Amaryllidaceæ* and *Liliaceæ* the anthers burst towards the centre of the flower, and are termed *introrse*; in *Berberis* *Iridaceæ*, and *Colchicaceæ* they burst outwards, *i.e.*, towards the perianth, and are called *extrorse*.

The pollen is formed, as we have seen, in the interior of the anther, generally in four regions known as *pollen-sacs*, or microsporangia. In each of these, numerous large cells, called pollen-mother-cells, which have all originated from the repeated division of one cell, the *archesporium*, divide into four *pollen-grains*, or microspores, by free-cell-formation. These grains generally become free in the cavity of the ripe anther-lobe formed by the breaking down of the tissue between two pollen-sacs; but in some cases each four grains remain united within the cell-wall of the pollen-mother-cell, and in *Orchidaceæ* the whole of the grains in each anther-lobe cohere into a mass termed a *pollinium*. Each pollinium is made up of numerous bodies termed *massulæ*, groups of grains resulting from the division of one mother-cell, and is furnished with a stalk-like structure or *caudicle*, at the end of which is a sticky gland called the *retinaculum*. In some cases, the retinacula of the two pollinia are united. There is but one such stamen in the flower (*see* p. 37), and whilst an insect is boring through the inner epidermis of the spur with its proboscis to get the nectar, which in this group is secreted within the petal, the sticky cement of the retinaculum fastens the pollinium on to its head. On the pollinium being withdrawn from the anther its caudicle bends until it is horizontal instead of vertical, so as to strike the stigma of the next flower visited by the insect, when a few massulæ being torn off, more will remain to pollinate other flowers.

Ordinary pollen-grains vary from $\frac{1}{200}$ to $\frac{1}{1000}$ of an inch in diameter, and they may be spherical, ovate, cylindric, trigonal, or other shapes. They are enclosed by a double membrane, an internal, the *intine* or endospore, and an external, the *extine* or exospore, the former of which is smooth, delicate, and transparent. The extine is coloured, generally yellow, and may be either smooth or have spiny (*echinulate*) or reticulate projections on it. In

Fig. 54.—Honeysuckle (*Lonicera Periclymenum*).

many trees, such as hazel, willow, and elm, the flowers are produced before the leaves in early spring, and are hence termed *precocious*. Such trees commonly produce an abundance of small-grained, spherical, smooth pollen-grains adapted to

be carried, unobstructed by foliage, by the wind to the stigma. In pines and firs the grains are rendered still more buoyant by the expansion of the extine into two hollow vesicles. These and other plants, such as *Plantago*, *Poterium*, and most grasses, in which the pollen is carried by wind, are called *anemophilous* (Greek ἄνεμος, *anemos*, wind; φίλος, *philos*, loved). Self-fertilising flowers also have their pollen small and smooth, but less in quantity. Large-grained pollen with protuberances is generally specially adapted to become entangled in the hairs on the legs and bodies of insects, and so carried to other flowers. Plants adapted to cross-pollination by insects are called *entomophilous* (Greek ἔντομα, *entoma*, insects). Thus *Malva rotundifolia* has small smooth pollen-grains; *M. sylvestris*, larger echinulate grains. The extine is commonly slashed with slits, or dotted over with pores, or holes in the extine, or with both, or the pores may be *operculate*, having, that is, small lid-like pieces of extine which are pushed up by the intine in germination. In gymnosperms the pollen-grain divides into two cells, each with a nucleus, one smaller than the other and projecting inwards from its side. This small cell (or male *prothallium*) sometimes divides into two or three cells. The nucleus of the larger cell (or *antheridium*) divides at least once, and it is this larger cell that germinates or pushes out its intine into one or more tubular processes termed *pollen-tubes*. In angiosperms the pollen-grain similarly divides into two primordial cells, a "prothallium" and an "antheridium," of which the former may divide; but they do not acquire cell-walls, so that the grain has been considered unicellular. When moistened or placed in the sugary secretion of the stigma the pollen-grain germinates just as does the spore of a fungus, putting out pollen-tubes through the pores or slits, which may have to grow some inches in length. Each of these tubes contains two nuclei, one behind the other, the one nearer the apex being termed *reproductive*, the hinder one *vegetative*. The pollen-tube is nourished by the tissue through which it grows, and even pierces its cells precisely as would a parasitic mould. In monocotyledons with long styles, and consequently exceptionally long pollen-tubes, the tube undergoes cell-division, the vegetative nucleus dividing, and a transverse cell-wall forming between its daughter nuclei, which may repeat the process. The conveyance of pollen by wind, insects, or other agency on to the stigma in angiosperms or into the micropyle in gymnosperms is called *pollination*; and, while some few plants, such as the bee-orchis (*Ophrys apifera*), require to be pollinated with the pollen of the same flower, in others that from another individual, or even from a distinct variety or species, is *prepotent* or germinates first; or the pollen of any flower if placed on the stigma of the same flower may, as in *Corydalis cava*, actually have a poisonous effect and blacken the stigma. As a rule, pollen will germinate on contact with any moisture, even on the stigma of some widely different plant; but in this case the tubes, though produced, will have no fertilising effect. Days, and in gymnosperms even months, may elapse between pollination and the final contact of the pollen-tube with the embryo-sac, when *fertilisation* takes place; but the two events are more commonly only a few hours apart.

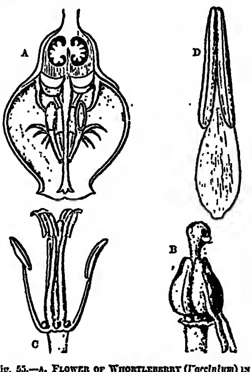


Fig. 55.—A. FLOWER OF WHORTLEBERRY (*Vaccinium*) IN SECTION. B. STAMENS AND PISTIL OF PANSY (*Viola tricolor*). C. TETRADYNAMOUS STAMENS OF A CRUCIFER. D. PETALOID STAMEN OF WHITE WATER-LILY (*Castalia speciosa*).

THE GYNÆCEUM.

The *gynæceum* (Greek γυναικεῖον, *gunaikeion*, belonging to women) or *pistil* is the collective name for the *carpels*, *carpellary leaves*, or female sporophylls, which among angiosperms bear the ovules or immature seeds containing the embryo-sac or megaspore. It may consist of one carpel (*monocarpellary*), as in *Leguminosæ* and *Drupaceæ*, or of more than one (*polycarpellary*); and, in the latter case, the carpels may be free (*apocarpous*), as in the buttercup, or united (*syncarpous*). In any case the carpellary leaf consists typically of three regions —the broad basal portion or *ovary*; the narrow or

way to a short stout filament, on which it swings like the ancient quintain.

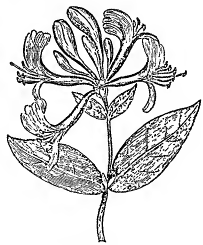
To discharge its pollen when ripe, the anther generally splits or *dehisces longitudinally*, by a slit

Fig. 53.—WHITE DEAD-NETTLE (*Lamium album*).

down the face of each lobe, as in lilies, grasses, violets, etc. When short and rounded, it sometimes dehisces *transversely*, by a horizontal split, as in *Alchemilla*. In the heath family (*Ericaceæ*) dehiscence is *porous*, by a hole at the top of each lobe; the lobes in some genera, such as the cranberries (*Vaccinium*), being produced upward into tubular processes. (Fig. 55, A.) In the barberry (*Berberis*) and in the bay-tree (*Laurus*) dehiscence is *opercular* or *valvular*, two parallel splits and one transverse one on the face of each lobe forming a little door or *operculum* which folds back in an upward direction. Dehiscence is often an important classificatory character, and from this point of view we must observe not only the mode, but also the direction in which it takes place. In *Compositæ*, *Amaryllidaceæ*, and *Liliaceæ* the anthers burst towards the centre of the flower, and are termed *introrse*; in *Berberis*, *Iridaceæ*, and *Colchicaceæ* they burst outwards, *i.e.*, towards the perianth, and are called *extrorse*.

The pollen is formed, as we have seen, in the interior of the anther, generally in four regions known as *pollen-sacs*, or microsporangia. In each of these, numerous large cells, called pollen-mother-cells, which have all originated from the repeated division of one cell, the *archesporium*, divide into four *pollen-grains*, or microspores, by free-cell-formation. These grains generally become free in the cavity of the ripe anther-lobe formed by the breaking down of the tissue between two pollen-sacs; but in some cases each four grains remain united within the cell-wall of the pollen-mother-cell, and in *Orchidaceæ* the whole of the grains in each anther-lobe cohere into a mass termed a *pollinium*. Each pollinium is made up of numerous bodies termed *massulæ*, groups of grains resulting from the division of one mother-cell, and is furnished with a stalk-like structure or *caudicle*, at the end of which is a sticky gland called the *retinaculum*. In some cases, the retinacula of the two pollinia are united. There is but one such stamen in the flower (*see* p. 37), and whilst an insect is boring through the inner epidermis of the spur with its proboscis to get the nectar, which in this group is secreted within the petal, the sticky cement of the retinaculum fastens the pollinium on to its head. On the pollinium being withdrawn from the anther its caudicle bends until it is horizontal instead of vertical, so as to strike the stigma of the next flower visited by the insect, when a few massulæ being torn off, more will remain to pollinate other flowers.

Ordinary pollen-grains vary from $\frac{1}{200}$ to $\frac{1}{1000}$ of an inch in diameter, and they may be spherical, ovate, cylindric, trigonal, or other shapes. They are enclosed by a double membrane, an internal, the *intine* or endospore, and an external, the *extine* or exospore, the former of which is smooth, delicate, and transparent. The extine is coloured, generally yellow, and may be either smooth or have spiny (*echinulate*) or reticulate projections on it. In



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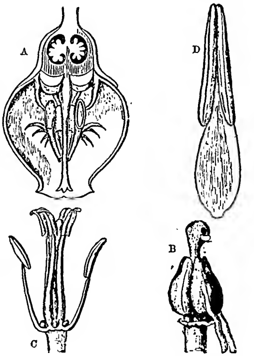

Fig. 55.—A. Flower of Whortleberry (*Vaccinium*) in Section. B. Stamens and Pistil of Pansy (*Viola tricolor*). C. Tetradynamous Stamens of a Crucifer. D. Petaloid Stamen of White Water-lily (*Castalia speciosa*).

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our "what will you bet?" or "how much is the stake?" etc.:—Es gilt ein Leben, there is a life at stake, etc.

EXAMPLES.

Er traf ihn der'gestalt mit seinem Schwerte, daß er zu Boden fiel.	He struck him with his sword so (in such a manner) that he fell to the ground.
Das Büb'chen freut sich sehr über sein neues Hütchen.	The little boy rejoices much over his (little) new hat.
Ich werde es so ein'richten, daß ich Sie bald besu'chen kann.	I will so arrange it, that I can soon visit you.
Der Mensch soll im Glücke, wie im Leiden, seine Blicke in die Höhe richten.	In prosperity, as in affliction, man should direct his look upward.

VOCABULARY.

Bewun'dern, to admire.
Brauchbar, useful, serviceable.
Brüder'chen, *n.* little brother, darling brother.
Der'gestalt, in such a manner. so.
Ein'richten, to arrange, order.
Fischchen, *n.* little fish.
Gänschen, *n.* gosling.
Gärtchen, *n.* little garden.
Häuschen, *n.* cottage.
Hütchen, *n.* little hat.
Kätzchen, *n.* pussy.
Kei'nesfalls, in no wise.
Kistchen, *n.* little chest.
Klatschen, to clap.
Lämmchen, *n.* lambkin.
Leistung, *f.* performance, accomplishment.
Leutchen, little people.
Niedlich, neat, nice, pretty.
Samstag, *m.* Saturday.
Spät, late.
Thierchen, *n.* little animal.

EXERCISE 118.

Translate into English:—

1. Haben Sie dieses niedliche Gärtchen gesehen? 2. Nein, denn ich bewunderte jenes hübsche Häuschen. 3. Es gehört zwei alten Leutchen, welche ich kenne. 4. Was sind das für niedliche Thierchen? 5. Es sind in dem Garten eine Menge ganz junger Lämmchen. 6. Dieses Märchen spielt mit seinem Brüderchen. 7. Wollen Sie mir jenes Kistchen geben? 8. Wollen Sie dieses auf dem Tischchen haben? 9. Sehen Sie, welch ein hübsches Hütchen! 10. Das Kindchen hat große Freude an seinem Kätzchen und an seinem Gänschen. 11. Richten Sie es so ein, daß Sie bis Samstag Morgen in meinem Hause sein können. 12. Machen wir es dergestalt, daß es für beide Zwecke brauchbar ist? 13. Er soll es so machen, daß er seine Bücher mitnehmen kann. 14. Ich richte es jedenfalls so ein, daß ich bis zehn Uhr bei Ihnen bin. 15. Wir machen es so, daß wir keinesfalls zu spät kommen. 16. Sagen Sie Ihrem Bruder, er möchte es dergestalt einrichten, daß es für Jedermann verständlich ist.

EXERCISE 119.

Translate into German:—

1. Dear father, will you buy me the little lambkin? 2. No, my dear daughter, but I will buy you the gosling and the little fish. 3. Have you seen that pretty cottage? 4. No; I admired that beautiful little garden. 5. Mary plays with the pussy, and her little brother with the little fish. 6. Look, what a beautiful little chest this is. 7. Men should at all times direct their thoughts to God. 8. Arrange it so, that I may find you to-morrow at home. 9. I hope you will arrange it so, that you may arrive on Monday morning. 10. What is this garden worth? 11. It is worth more than you believe. 12. What were these books worth ten years ago? 13. What will you bet against this horse? 14. There are five pounds at stake.

Eigen, Finden, AND Halten.

The word eigen (own) is often used with an article as also with a pronoun preceding, as:—Er hat ein eigenes Pferd, he has (an own horse) a horse of his own. Eigen has also the kindred signification, "peculiar," "singular," as:—Er ist ein eigener Mensch, he is a *peculiar* man, etc.

Finden (to find) often answers to our verbs "to think" or "consider," as:—Ich finde den Wein sehr gut, I (find) *think* the wine very good; Ich finde es unrecht, daß er das gethan hat, I *think* (or *consider*) it wrong that he has done that.

Halten (to hold), with its proper case, followed by für, has, like finden, the sense "to think" or "consider," as:—Er hält mich für seinen Feind, he thinks me (*lit.*, holds me for) his enemy. Followed by auf, halten also means "to esteem," "regard," as:—Ich halte viel auf ihn, I think much of him.

EXAMPLES.

Nichts ist so sehr unser eigen, als unsre Gedan'ken; alles An'dere ist außer uns.	Nothing is so much our own, as our thoughts; all else is exterior to us.
Die meisten Menschen sind von Empfin'dung ihres eignen Werths auf'geblasen, weil sie nicht wissen, was der wahre Werth des Menschen ist.	Most men are puffed up by a feeling of their own worth, because they do not know what the true worth of man is.
Wer hat je den herben Trank des Schicksals gern und willig genom'men?	Who has ever cheerfully and voluntarily taken the bitter cup of fate?
Der Graf kommt so eben mit seinem Gefol'ge von der Jagd.	The count is just coming, with his retinue, from the chase.
Halte je fest an dem Glauben an Gott, den Lenker deines Schicksals.	Hold fast to thy (the) faith in God, the disposer of thy destiny.
Wir beur'theilen die Menschen in vielen Fällen nur nach dem Schein, und halten manche für klug, weil sie	We estimate men in many cases only by the appearance, and regard many as wise because

Durch ein solches Betra'gen muß nothwen'diger Weise ein Bruch zwischen beiden Freunden entste'hen.	By such conduct, a breach between the two friends must necessarily arise.
Er bindet sich an keine beson'deren Stunden, sondern ar'beitet nach Muße.	He confines himself to no particular hours, but works according to (his) leisure.

VOCABULARY.

Amts'geschäft, *n.* official duty, business.
A'sien, *n.* Asia.
Aus'richten, to do, perform.
Beina'he, almost, near, about.
Berüh'ren, to touch, to come in contact with.
Beschäf'tigung, *f.* business, employment, occupation.
Feu'ersbrunst, *f.* fire, conflagration.
Flucht, *f.* flight, escape.
Fristen, to prolong.
Furchtbar, tremendous, terrible.
Gefahr, *f.* danger.
Gehor'chen, to obey, to be obedient.
Gewalt'sam, violently, forcibly.
Hinweg'schleppen, to draw away, to take away by force.
Hof, *m.* court.
Irrung, *f.* error, mistake.
Kleiden, to dress, clothe.
Legitimi'ren, to legitimate, identify.
Litera'risch, literary.
Men'schenleben, *n.* human life.
Miß'verständniß, *n.* misunderstanding.
Mode, *f.* mode, fashion, custom.
Muße, *f.* leisure, ease.
Noth'gedrungen, compulsory, forcedly.
Perser, *m.* Persian.
Persisch, Persian (*adj.*).
Römer, *m.* Roman.
Scherz'weise, by way of jest, jokingly.
Schnee'lawine, *f.* avalanche.
Schweiz, *f.* Switzerland.
Übrighaben, to have left.
Vergnü'gung, *f.* pleasure.
Verhin'dern, to hinder, stop from.
Verse'hen, *n.* oversight, inadvertence.
Vor'zugsweise, preferably, especially.
Weise, *f.* way, manner.
Wichtig, considerable, important.
Wille, *m.* will, mind.
Zu'fluchtsstätte, *f.* asylum, refuge.

EXERCISE 116.

Translate into English :—

1. Die Franzosen eroberten Spanien mit Gewalt der Waffen. 2. Die Schneelawinen in der Schweiz stürzen oft mit furchtbarer Gewalt in die Thäler. 3. Die Einwohner dieses Landes schleppt man gewaltsam hinweg. 4. Mit aller Macht konnte er nichts ausrichten. 5. Die Griechen vertheidigten sich mit aller Macht gegen die Perser. 6. Der Schwächere muß nothwendiger Weise dem Stärkeren gehorchen. 7. Beinahe ganz Asien gehorchte dem Willen der Römer. 8. Um sein Leben zu fristen, mußte er nothwendiger Weise arbeiten 9. Themistocles suchte nothgedrungener Weise eine Zufluchtsstätte am persischen Hofe. 10. Mein Freund vertraute mir gestern Abend unter vier Augen ein wichtiges Geheimniß an. 11. Nachdem die Schule aus war, spielten die Kinder unter den Bäumen des Gartens. 12. Alle Anwesenden kleideten sich nach der Mode von siebenzehn hundert neun und achtzig. 13. Wegen seiner Amtsgeschäfte hatte er wenig Muße zu Vergnügungen übrig. 14. Schiller konnte sich nun nach Muße in Mannheim literarischen Beschäftigungen widmen. 15. Ich habe aus Versehen einen andern Regenschirm mitgenommen. 16. Irrungen entstehen aus Mißverständnissen und Versehen.

EXERCISE 117.

Translate into German :—

1. The inhabitants of Holstein defended themselves with all their power against the Danes. 2. William the Conqueror overcame England by force of arms. 3. Those brave soldiers forced their way with tremendous violence through the ranks of the enemy. 4. They forcibly hindered him from making his escape. 5. Do you like the German language? 6. Yes, I do; but I especially like the Italian language. 7. At the present time he is especially occupied with the German and Spanish languages (say *language*). 8. Fortunately I found my friend at home. 9. He is obliged to listen to the orders of his superiors. 10. Most people dress themselves after the French fashion. 11. I took unknowingly the hat of another. 12. My friend fortunately discovered the danger which threatened him. 13. By way of jest he told me many a truth. 14. Secretly you may tell many insults. 15. The princes of Germany proceed arbitrarily in ruling their dominions.

DIMINUTIVES, ETC.

The syllables -chen and -lein are suffixed to nouns, and form diminutives. These diminutives are always of the neuter gender, and change the radical vowel, when it admits of it :—Der Hügel, the hill; Das Hügelchen, the hillock; Die Kugel, the globe *or* ball; Das Kügelchen, the globule *or* the little ball. Nearly all nouns may take these suffixes, and drop a final e or en, as :—Der Knabe, the boy; Das Knäblein, the little boy; Die Stube, the room; Das Stübchen, the little room. They are used also as terms of endearment or familiarity, especially by children, as:—Väterchen, dear father; Mütterchen, dear mother; Schwesterchen, dear sister, etc.

In die Höhe, "in the high," "on high," "upward," etc., as :—Er sprang in die Höhe, he sprang up; In die Höhe richten, to raise, to elevate, to direct upward.

Gelten is variously translated, "to be worth," "to pass for," etc., as :—Diese Bücher werden für alte gelten, und ich werde deshalb keinen Eingangszoll zu bezahlen haben, these books will pass for old ones, and I shall therefore have no duty to pay; Dieser Mann gilt viel in der Stadt, this man has great influence in the city; Was gilt dieses Pferd? what is this horse worth?

Was gilt's? or Was gilt die Wette? is equivalent to

Dieser Mann ist ein gebor'ner Amerika'ner.	This man is a native American.

VOCABULARY.

Amerika'nerin, *f.* American (woman).
Aus'zeichnung, *f.* distinction.
Beistand, *m.* assistance, succour, support.
Blut-gerüst, *n.* scaffold.
Darin, therein, in it.
E'benbild, *n.* image, exact likeness.
Eintritt, *m.* entrance.
Erfech'ten, to win in fight, conquer.
Finster, dark.
Gebo'ren, born.
Gebür'tig, native.
Göttlich, divine.
Hoch'verrath, *m.* high treason.
Klei'nigkeit, *f.* trifle, small matter.
Lustig, merry, sportive.
Musik'lehrer, *m.* music-master.
Narr, *m.* fool.
Nie'derlage, *f.* discomfiture, defeat.
Nordame'rika, *n.* North America.
Schlüssel, *m.* key.
Stehlen, to steal.
Stemmen, to resist, oppose, stem.
Streiten, to fight, combat.
Um'kommen, to perish.
Un'bedeutend, unimportant, insignificant.
Unklug, imprudently.
Unterdrück'en, to oppress.
Verzwei'feln, to despair.
Wiese, *f.* meadow.
Zweifeln, to doubt.

EXERCISE 122.

Translate into English:—

1. Wer sich das Göttliche will und das Höchste im Leben erfechten, scheue nicht Arbeit und Kampf (Körner). 2. Wer gewinnen will, muß wagen. 3. Dieses Buch ist mir lieb; wer es stiehlt, der ist ein Dieb. 4. Wer nichts lieben will, als sein Ebenbild, hat außer sich nichts zu lieben. 5. Wer zweifelt, verzweifelt. 6. Wer gegen sein Vaterland streitet, ist ein Verräther. 7. Wer sich in Gefahr begiebt, kommt darin um. 8. Wer dem Unterdrückten nicht beisteht, verdient auch keinen Beistand. 9. Wer sich gegen das Schicksal stemmen will, ist ein Narr. 10. Sind Sie ein geborner Engländer oder Amerikaner? 11. Ich bin keins von beiden, ich bin ein geborner Deutscher. 12. Wer ist Ihre Freundin? 13. Sie ist eine Amerikanerin, gebürtig aus New-York. 14. Woher ist Ihr Freund gebürtig? 15. Er ist aus England gebürtig. 16. In welchem Lande wurden Sie geboren? 17. Ich bin in den Vereinigten Staaten von Nordamerika geboren. 18. Ich mache mich über diesen Mann lustig. 19. Sie sollten sich nicht über ihn lustig machen. 20. Er macht sich über Jedermann lustig.

EXERCISE 123.

Translate into German:—

1. He who assists the poor will receive divine assistance. 2. He who would have entrance everywhere must have golden keys. 3. He who fights for his country deserves distinction. 4. He who wishes to learn German must give himself some trouble. 5. He who dies for his king, dies with glory. 6. He who commits high treason dies mostly upon the scaffold. 7. They are born under a happy star. 8. In which country were those ladies born? 9. They were born in Italy, in the year 1795, but their mother was born in England. 10. Are these ladies natives of Germany? 11. No, they are natives of France. 12. Our music-master is a native of Italy, and was born in Florence. 13. I will do what I have promised. 14. Show me what you have found. 15. What enhances the glory of this hero is his modesty. 16. Let us grant him what we at first refused. 17. Thou hast never told us what they have trusted you with. 18. Why do you make yourself merry at the misery of the oppressed? 19. The fruits which we saw in the garden of our neighbour were not so good as those which grew in yours.

Auf eine Rechnung setzen answers to our "place to an account," as:—Diese Bücher können Sie auf meine Rechnung setzen, these books you may place (*or* charge) to my account. So also:—Er machte sich auf meine Rechnung (or Kosten) lustig, he made himself merry at my expense.

Preisgeben is compounded of Preis, *prize*, and geben, *to give*, as:—Er hat mich verlassen, und mich meinen Feinden Preis gegeben, he has deserted me, and exposed me to my enemies.

Hervor (forth, out) is compounded with many verbs, and often expresses mere prominence, as:—Er hat diesen Punkt besonders hervorgehoben, he has given this point especial importance.

EXAMPLES.

Er ließ Alles, was er holte, auf meine Rechnung setzen; allein, ich werde nur das beza'hlen, was ich selbst geholt' habe.	He had everything that he went for placed to my account, but I shall only pay (for) what I went for (got) myself.
Er suchte Alles, was er verübt' hatte, von sich ab und auf meine Schultern zu wälzen.	All that he had committed, he sought to remove from himself and bring to my charge (upon my shoulders).
Ich mag weder auf Rechnung (or Kosten) eines Andern spotten, noch mich selber dem Gespött'e Preis geben.	I wish neither to scoff at the expense of another, nor expose myself to (the) ridicule.
Ich habe die Arbeit gethan', und verlan'ge nun meinen Lohn.	I have done the work, and now demand my pay.
Von nun an hatte das Leben allen Reiz für ihn verlo'ren.	From now (this time forward) life had lost all attraction for him.
Endlich langte die versproch'ene Hülfe an.	At last the promised aid arrived.

VOCABULARY.

Ab'sichtlich, purposely.
Ab'wesend, absent.
Anbruch, m. break, beginning.
Artig, good, well-behaved.
Befrei'en, to set free.
Behaupt'ung, f. assertion, statement.
Bess'erung, f. improvement.
Büßen, to atone for, suffer for.
Entschul'digen, to excuse, exculpate.
Erbit'tern, to embitter.
Erklä'ren, to declare, explain.
Ja'nuar, m. January.
Kei'neswegs, in no wise, by no means.
Lustig, merry.
Na'mentlich, especially.
Öf'fentlich, openly.
Rauch, m. smoke.
Rechnung, f. account, score.
Strafbar, punishable.
Verzö'gerung, f. delay, putting off.
Wacker, valiant, brave, honest.
Wälzen, to roll, remove.
Zart, tender, frail.

EXERCISE 124.

Translate into English :—

1. Entschuldigen Sie mich, mein Herr, es ist nicht vorsätzlich geschehen. 2. Wenn er es absichtlich gethan hat, so ist er keineswegs zu entschuldigen. 3. Obgleich Sie es nicht mit Absicht gethan haben, so ist es doch strafbar. 4. Hätten Sie es vorsätzlich gethan, so müßten Sie sich schämen. 5. Den Gefangenen hat man absichtlich befreit. 6. Dieser Mann hat nicht absichtlich diese Verzögerung herbeigeführt. 7. So lange noch solche Männer an der Spitze des Staates stehen, können wir an keine Besserung denken. 8. So lange ich keine Beschäftigung habe, kann ich nicht zufrieden sein. 9. So lange ihr artig seid, sollt ihr alles haben, was ihr braucht. 10. So lange die Welt steht, hat man keine solche Behauptung gemacht. 11. Ich arbeite für dich, so lange du krank bist. 12. Wir sorgten für seine ganze Familie, so lange er abwesend war. 13. Sie können, so lange Sie wünschen, in meinem Hause wohnen. 14. Wenn er sich nicht so lange aufhält, so kann er auch meine Briefe nicht mehr bekommen. 15. Dieser Mann arbeitet von Anbruch des Tages bis spät in die Nacht. 16. Von jetzt an gehe ich alle Tage vom Fluß bis an den Berg spazieren. 17. Ich habe nun einen Brief erhalten und werde, so bald ich kann, zu meinen Freunden reisen. 18. Bis zum zwanzigsten Januar werde ich alle meine Geschäfte geordnet haben. 19. Da ich jetzt angekommen bin, so werde ich mit ihm sprechen, so bald ich ihn sehe. 20. Als sie endlich kamen, war es Nacht geworden.

EXERCISE 125.

Translate into German :—

1. The books which I bought of you, you may charge to my account. 2. The conquerors made themselves merry at the expense of their enemies. 3. As long as the man has employment, he may be contented. 4. As long as the world stands, the word of God will never vanish. 5. I will work for my friend as long as he is ill. 6. As long as the scholars are diligent, their teacher will praise them. 7. You can remain with my family as long as you wish. 8. If you remain till I have finished these letters, you may take them to my friend. 9. From now we shall give more time to study. 10. The ship was exposed to the wind and waves. 11. From the break of day till late in the evening the town was exposed to the fire of the enemy. 12. The sun breaks forth between the clouds. 13. The Athenians declared none but Jupiter should henceforth reign in Athens. 14. As long as my heart approves of my conduct, the censure of the people shall give me no pain. 15. He has given to the last point in his speech especial importance. 16. They were amusing themselves at his expense, and he did not perceive it.

KEY TO EXERCISES.

Ex. 110.—1. He who is careful in his youth, need not have cares in his old age. 2. Study thyself, not only in the society of strangers, but also when thou art alone, that thou mayest know thyself. 3. He who does not always study himself never acquires self-knowledge. 4. The ancient Germans used generally to sacrifice to their gods in old groves of oak. 5. Good children take care of their parents in their old age. 6. My friends are accustomed to drink water in the morning. 7. He takes rest morning and evening. 8. We are accustomed to drink coffee instead of tea. 9. To take care of his health is his greatest concern. 10. He is accustomed to work in the morning, and read in the afternoon. 11. He who fosters idleness, fosters sin also. 12. Cherish virtue and not wickedness. 13. He is not accustomed to rise before eight o'clock. 14. It is not the custom to say in America as in Germany, "I wish you a good appetite." 15. Man often troubles himself about his subsistence more than is necessary. 16. The ant takes care of its food in the summer against the winter. 17. The German emperor, Maximilian I., took care to restore the internal tranquillity of Germany directly on his accession to the government.

Ex. 111.—1. Nehmt Euch vor denen in Acht, welche glatte Worte, böse Gedanken und ein falsches Herz haben. 2. Er sorgt mehr für seinen Geist als für seinen Körper. 3. Wir pflegen, anstatt des Kaffees, Thee zu trinken. 4. Die Griechen pflegten schon lange vor Christi Geburt der Kunst und Wissenschaft. 5. Er pflegt um sechs Uhr aufzustehen. 6. Ich werde dieses Buch in Acht nehmen, bis Sie wiederkommen. 7. Er pflegt seiner Gesundheit. 8. Habe Acht auf dich, nicht nur in Gesellschaft, sondern auch wenn du allein bist. 9. Gute Kinder geben Acht auf das, was ihre Eltern ihnen sagen. 10. Wir müssen uns vor unsern Feinden in Acht nehmen. 11. Der Hamster sorgt im Sommer für seine Nahrung auf den Winter.

Ex. 112.—1. Those who go walking too often, at last accustom themselves to idleness. 2. To take a walk half an hour after dinner is very conducive to health. 3. In Italy many drive out with mules. 4. One generally sees more gentlemen walking, than riding on horseback. 5. The visitors (*lit.* guests under cure) at Wiesbaden often ride on mules upon the top of the Taunus mountains. 6. Journeys on foot are often more agreeable than in a coach or on horseback. 7. The Laplanders ride in sledges, and make use of reindeer instead of horses. 8. He scarcely took his eyes off his relations, whom he had not seen for so long a time, and rejoiced at their communications. 9. Most of the officers have interceded with the general for this young soldier. 10. I applied to my friends in my troubles; but wherever I turned, I saw only indifferent looks. 11. He stole

my watch and some other articles without my observing it. 12. He who prides himself on his knowledge, thereby proves that he knows less than he boasts and wishes to make others believe. 13. I hope you will not suppose I offended you purposely. 14. God forbid! I never did nor would believe anything so bad of you. 15. I hope you will not remain at home during this beautiful weather. 16. Oh, no! I have no inclination to spend such a beautiful day within the four walls of my room. 17. There are several who have applied for this office, viz., the following. 18. I cannot help telling you that this treatment does not please me. 19. I cannot help thanking you very heartily. 20. When I wished to shoot at the wolf my gun missed fire.

Ex. 113.—1. Er konnte nicht umhin, seinen Tadel auszusprechen. 2. Bewahre uns, o Herr, vor Sünde. 3. Ich konnte nicht umhin, das Unrecht, welches ich erlitten hatte, zu vergeben. 4. Indem er dieses sagte, sank er ohnmächtig nieder. 5. Wir werden langsam nach dem Parke reiten. 6. Die Königin ritt gestern spazieren. 7. Dieser Kaufmann thut groß mit seinen Reichthümern. 8. Der Araber reitet mit unglaublicher Schnelle. 9. Wenn die alten Ritter in den Krieg ritten, so waren ihre Pferde gepanzert. 10. Könige und Fürsten pflegen mit sechs Pferden spazieren zu fahren. 11. Als er hätte entfliehen können, versagten ihm seine Kräfte. 12. Das Holz wird zum Bauen verwendet. 13. Er hat den größten Theil seiner Jugend auf wissenschaftliche Studien verwendet. 14. Reisen durch das Rheinthal sind angenehmer zu Fuß als zu Pferde. 15. Johann führt seine Schwester durch den Park spazieren, während ihr Vater spazieren reitet.

Ex. 114.—1. The physician has advised me to go out as little as possible. 2. Emily works as little as possible, in order to preserve the delicacy of her hands. 3. Children should be unemployed as little as possible at any time. 4. He speaks so little, in order to excite no attention. 5. Ferdinand is now very little at home. 6. On my last journey I had very little luggage with me. 7. Will you have some meat? 8. Yes, but only very little. 9. There remains nothing else for him but to beg or to work. 10. There remains nothing else; you must act now. 11. Of all his property, there remained nothing else for him but a spot of land. 12. Of all the flowers, this rose only remained. 13. Of the whole regiment, he only remained. 14. I cannot get rid of these sorrowful thoughts. 15. In order to get rid of our false friends, we must lend them money. 16. Grant him his request, in order to get rid of him. 17. Now the sport commenced afresh. 18. The plaster of the wall breaks off. 19. When the war recommenced, he took the field with a great army. 20. The gun went off as he was going to take it.

Ex. 115.—1. Der Arzt rieth meiner Schwester, so viel als möglich zu Hause zu bleiben. 2. Ein Lehrer sollte seine Schüler so wenig als möglich unbeschäftigt lassen. 3. Der Redner sprach mit großer Begeisterung, um die Aufmerksamkeit seiner Zuhörer zu steigern. 4. Die meisten Reisenden nehmen so wenig Gepäck als möglich mit sich. 5. Wollen Sie Äpfel haben? 6. Ich danke Ihnen, mein Herr, ich habe ganz genug. 7. August ist jetzt sehr viel zu Hause, daher können wir zu ihm gehen. 8. Es bleibt ihm nichts übrig, als sich seinem Schicksale zu unterwerfen. 9. Es blieb mir nichts Anderes übrig, als vor dem Feinde zu fliehen. 10. Von all seiner Habe blieb nichts übrig, als ein Garten. 11. Ich kann meinen Schnupfen nicht los werden. 12. Gewähre die Bitte dieses falschen Freundes, dann wirst du ihn los werden. 13. Wer hat den Fuß dieses Tisches abgebrochen? 14. Die Magd brach ihn ab, als sie das Zimmer reinigte. 15. Friedrich der Große zog an der Spitze seiner Armee in den Krieg. 16. Das Gewehr ging los, sonst würde er den Hasen geschossen haben.

GEOGRAPHY.—XX.

[Continued from p. 62.]

THE UNITED STATES (continued).

Divisions and Chief Towns.—The fifty-one divisions may be grouped as Atlantic or Eastern, Central, and Western or Cordilleran. The thirteen states which declared themselves independent in 1776 are marked with an asterisk, and the numbers in round brackets after the name of each division express its area in thousands of square miles. They range in size from Columbia, 70 square miles, Rhode Island, 1,250, Delaware, 2,050, and Connecticut, 5,000, or about the size of Yorkshire, to Maine (33), about that of Ireland, New York (49), about that of England, California (158), nearly equal to Spain, Texas (265), larger than Austria-Hungary, and Alaska (531). The Atlantic States fall into three groups, North, Middle, and South. The North or *New England States* are Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. In MAINE (33), *Portland* has a fine harbour. In *NEW HAMPSHIRE (9), *Concord* is a railway centre; as also in *VERMONT (9) is *Burlington*. In *MASSACHUSETTS (8), *Boston* [449], on Massachusetts Bay, the centre of culture in the United States, has also a great trade. In the suburb of *Cambridge* is Harvard College, and in that of *Charlestown* is Bunker's Hill, scene of the British defeat in 1775. *Lowell*, on the River Merrimac, 25 miles inland, the "American Manchester," is the chief seat of cotton manufactures. *Plymouth*, on Cape Cod Bay, the landing-place of the "Pilgrim Fathers," 1620. In *RHODE ISLAND (1), *Providence* [132] is a manufacturing town. In *CONNECTICUT (5), *New Haven* is the seat of Yale College.

The Middle Atlantic States are New York, New Jersey, Pennsylvania, Delaware, and Maryland. In NEW YORK (49), *Albany* [95], on the River Hudson, is the capital. *New York* [2,000], on Manhattan Island, at the junction of the Hudson and East River, 200 miles south-west of Boston, 3,070 miles or 7 days from Liverpool, with an excellent harbour, by position and climate the chief port, is the largest city in America and the third port in the world. *Brooklyn* [1,100], on Long Island, is now connected with New York by a bridge. *Buffalo* [255], on Lake Erie, has a great trade by water in

grain and timber. In *NEW JERSEY (7), *Jersey City* [163], on the west bank of the Hudson, is a suburb of New York. In *PENNSYLVANIA (45), *Philadelphia* [1,142], on the River Delaware, 90 miles south-west of New York, is the second city in America. *Pittsburg* [239] and *Alleghany*, at the junction of the Alleghany and Monongahela to form the Ohio, are the centre of the coal, iron, and petroleum region. In *DELAWARE (2), *Wilmington* has an arsenal. In *MARYLAND (12), *Baltimore* [434], on Chesapeake Bay, exports tobacco and cotton.

The South Atlantic States are Virginia, Columbia, North and South Carolina, Georgia, and Florida. In *VIRGINIA (42), *Richmond*, on the James River, the capital, exports tobacco. In the DISTRICT of COLUMBIA, Washington [230], on the Potomac, 3,850 miles from London, is in 77° 3' W. long., and 38° 52' N. lat. The chief buildings are the Capitol, where Congress meets, and the White House, the president's residence. In *NORTH CAROLINA (52) are extensive pine-barrens. In *SOUTH CAROLINA (30), *Charleston* exports cotton, as does also, in *GEORGIA (59), *Savannah*, on the Savannah River. FLORIDA (58), ceded by Spain, is the southernmost state, swampy, exporting oranges.

The Central States also fall into three groups, those north of the Ohio River, those south of it, and those west of the Mississippi. North of the Ohio are Ohio, Indiana, Illinois, Wisconsin, and Michigan. In OHIO (41), *Cincinnati* [297], on the Ohio, has a great pork trade. *Cleveland* [261], on the south of Lake Erie, has iron and ship-building works. In INDIANA (36), *Indianapolis* is a railway centre. In ILLINOIS (56), *Chicago* [1,500], at the south of Lake Michigan, 9 days from London, the largest grain market in the world, a railway centre, has grown in the last sixty years, with great trade also in timber and pork. In WISCONSIN (56), *Milwaukee* [201], on the west coast of Lake Michigan, has large corn, timber, and lead trade. In MICHIGAN (59), *Detroit* [206], from its position between Lakes Huron and Erie and on the Canadian frontier, has a large trade.

South of the Ohio are West Virginia, Kentucky, Tennessee, Alabama, and Mississippi. In WEST VIRGINIA (21) are no large towns. In KENTUCKY (40), *Louisville* [161], on the Ohio, is the centre of the tobacco trade, trading also in flour, pork, and hemp. In TENNESSEE (42), *Memphis*, on the Mississippi, has a large cotton trade. In ALABAMA (52), *Mobile*, at the mouth of the Alabama, exports cotton. In MISSISSIPPI (46), *Vicksburg*, on the Mississippi, has a river traffic.

West of the Mississippi are Minnesota, Iowa, Missouri, Arkansas, and Louisiana. In MINNESOTA (83), the contiguous towns of *St. Paul* and *Minneapolis*, at the head of the navigation of the Mississippi, have numerous flour mills. Of IOWA (56), the central town of *Des Moines* is the capital. In MISSOURI (69), *St. Louis* [452], a little below the confluence of the Missouri and Mississippi, at the lowest bridge over the Mississippi, 1,130 miles above New Orleans, is a depôt for enormous river and railroad trade, having also iron manufactures. In ARKANSAS (53), *Little Rock* is the capital, chosen, as usual throughout the States, for its central position. In LOUISIANA (48), purchased, with much north-western territory, from France in 1803, *New Orleans* [275], on the delta of the Mississippi, is the chief cotton port in the States, also exporting sugar, tobacco, and corn.

The Western States fall into four groups—those on the Great Plains, those on the slopes of the Rocky Mountains, those in the Great Basin, and those on the Pacific coast. On the Great Plains are TEXAS (265), the INDIAN TERRITORY (61), KANSAS (82), NEBRASKA (76), SOUTH (75) and NORTH DAKOTA (75), and OKLAHAMA (37), with no towns of much importance except *Galveston*, the Gulf port of Texas, and *Omaha*, in Nebraska, where the Missouri is bridged by the Union Pacific Railroad.

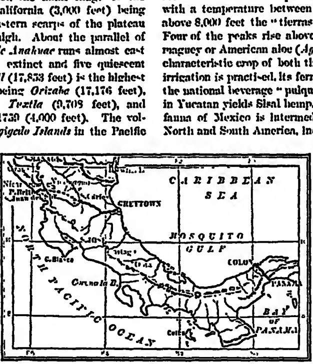
The Rocky Mountain States are MONTANA (146), WYOMING TERRITORY (97), COLORADO (101), and NEW MEXICO TERRITORY (122). In the north-west of Wyoming is the *Yellowstone National Park*, a large area with grand mountain scenery, geysers, and extinct volcanoes. These are mining states, and *Denver* is the chief town of the silver district of Colorado, *Santa Fé*, of New Mexico.

The Great Basin States are the Territories of ARIZONA (113), UTAH (85), and IDAHO (84), and the State of NEVADA (110). These are largely desert, Arizona and Utah including the "Painted Desert" crossed by the cañons of the Colorado, with brilliantly coloured rocks forming their sides. Of Utah, the Mormon territory, *Salt Lake* is the capital. Of Nevada, a silver-mining state, *Virginia City*, near the Comstock lode, is the chief town.

The Pacific States are CALIFORNIA (158), OREGON (96), WASHINGTON (69), and ALASKA TERRITORY (531). In California, *San Francisco* [299], 13 days from London, the terminus of the Union Pacific Railroad, on a grand natural harbour, land-locked, with an entrance, "the Golden Gate," a mile wide, has a large Chinese population, and trades with Japan, China, and Panama, exporting gold, wheat, wine, and fruits. *Olympia*, the capital of Washington, is on Puget Sound, whence the timber of that state and of Oregon is exported. Colonies; Cuba and Puerto Rico in the West Indies; and the Philippine Islands.

MEXICO.

Physical Characters.—Bounded on the north by the United States (California, Arizona, and New Mexico); on the east by Texas and the Gulf of Mexico; on the south by Guatemala and British Honduras; and on the west by the Pacific; Mexico (*Estados unidos de Mexico*) lies between 33° and 15° N. lat. and between 87° and 117° W. long. (being thus almost bisected by the Tropic of Cancer), and tapers southward from a width of 1,000 miles to 130 at the *Isthmus* of *Tehuantepec*. Its area is about 751,000 square miles, *i.e.*, six times that of the British Isles or between eight and nine times that of Great Britain. It has a coast-line of about 4,200 miles on the Pacific and 1,600 miles on the Gulf; but the small inlets of *Acapulco* and *San Blas* on the former are almost the only safe harbours. Mexico is mainly a vast table-land with a mean elevation of 7,000 to 8,000 feet, with its most abrupt slope on the east side but with lofty western scarps and cross ridges. The *Sierra Madre* thus runs parallel with the west coast and has a mean elevation of 10,000 feet, the axial range of the peninsula of Lower California (3,000 feet) being parallel to it. The eastern scarps of the plateau are about 6,000 feet high. About the parallel of 19° N. the *Cordillera de Anahuac* runs almost east and west with several extinct and five quiescent volcanoes. *Popocatepetl* (17,853 feet) is the highest of these, the others being *Orizaba* (17,176 feet), *Colima* (12,800 feet), *Toxtla* (9,708 feet), and *Jorullo*, upheaved in 1759 (4,000 feet). The volcanic group of *Revillagigedo Islands* in the Pacific and the mountain axis of Cuba and Hayti to the east probably form part of one line of igneous upheaval. South of this line is the *Tehuantepec* isthmus, where the Cordillera narrows to a single and discontinuous chain, only 4,000 feet high; and to the east and north-east extends the low-lying *Yucatan Peninsula* east of *Campeche Bay*, ending in *Capes Palmas* and *Catoche*. The rivers are mostly mountain torrents flowing in cañons or "barrancas," and, therefore, useless for irrigation, and even the *Rio Grande del Norte*, the largest, which forms the Texan frontier, is only navigable for a few miles above the port of *Matamoros* near its mouth. In the southern or Anahuac plateau are extensive lakes, mostly containing carbonate of soda, but, probably from the reckless destruction of the forests, these have been shrinking since the Spanish conquest (A.D. 1521). The northern part of Mexico is a continuation of the arid desert region of the United States; and the Californian peninsula is subject to excessive droughts, though with a climate resembling that of Italy; but within the tropics the climate depends mainly upon altitude. From sea-level to 3,000 feet extend the "tierras calientes" or hot lands, including most of Yucatan and Tehuantepec and the coast, with a temperature between 60° and 110° F., humid and unhealthy, with extensive virgin forests. Maize, the staple food, here yields from two to four crops of from 200- to 400-fold within the year; sugar-cane, rice, indigo, cotton, tobacco, coffee, cocoa, vanilla, and bananas flourish; and mahogany, rosewood, rubber, jalap, and sarsaparilla are produced. Between 3,000 and 8,000 feet are the "tierras templadas," or temperate lands, with a temperature between 50° and 86° F., and above 8,000 feet the "tierras frias" or cold lands. Four of the peaks rise above the snow-line. The maguey or American aloe (*Agave americana*) is the characteristic crop of both these regions, in which irrigation is practised, its fermented juice yielding the national beverage "pulque." An allied species in Yucatan yields Sisal hemp, a valuable fibre. The fauna of Mexico is intermediate between that of North and South America, including bears, coyote, skunk, bison, beaver, rattle-snake, and mocking-bird, with monkeys, puma, jaguar, sloth, tapir, iguana, boa, scorpions, tarantulas, parrots, and humming-birds. Geologically the country consists mainly of crystalline rocks which are rich in metalliferous ores, especially of silver.

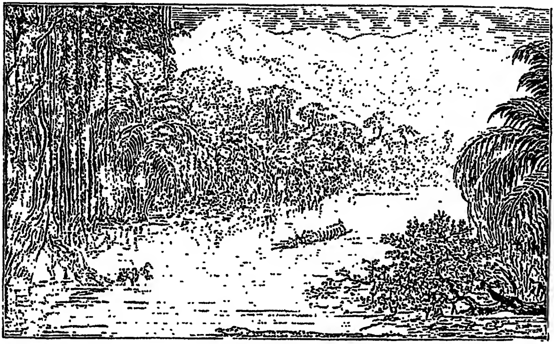


MAP SHOWING ROUTES OF NICARAGUA AND PANAMA CANALS.

Population and Industries. — Of the population of about twelve millions, two-thirds are Indians and half-castes ("mestizoes"), the dominant minority being of Spanish descent. Cattle, fine horses, mules, and sheep are raised in vast numbers in the north;

but in the south, agriculture, especially maize, sugar, coffee, tobacco, and cotton cultivation, and agricultural industries, especially sugar-refining, prevail. Pulque distilling is an important home industry. Silver and gold form 70 per cent. of the exports, which amount to about eight millions sterling annually, fibre, coffee, and hides ranking next in importance. There are valuable pearl fisheries in the Gulf of California. *Vera Cruz*, on Campeche Bay, the chief port, trades with Liverpool, Southampton, and the United States: but trade with Great Britain seems to be declining. *Acapulco*, on the west coast, has a trade, in German hands, with Panama and San Francisco. Over 6,600 miles of railway are open, including lines from the capital to the Texan frontier, bringing it within six days' journey of New York. A ship-railway 135 miles in length across the Tehuantepec isthmus is in progress.

Government, Education, etc. — Mexico, which before 1821 was the Spanish colony of New Spain, consists of twenty-seven confederate states, two territories, and a small federal district including the capital. The republic is governed by a president, a senate of two members from each state, elected by universal suffrage every four years, and a lower house of one member for every 40,000 inhabitants, elected every two years. The army on a war footing consists of 160,000 men, and the navy of seven gun-boats. The annual revenue and expenditure is about nine millions sterling; the public debt about sixteen millions. The



ON THE RIO POLOCHIC.

Catholic religion prevails, but there is no establishment, nor is any religious body allowed to possess land. Education is advancing, there being in all nearly 7,500 schools supported by public funds.

Chief Towns.—Mexico [314], on the southern plateau, at an altitude of 7,550 feet, in lat. 19° 25' N. and long. 99° W., or about 6¾ hours slow by Greenwich time, 173 miles from Vera Cruz, 290 from Acapulco, 863 from the Texas frontier, and about fifteen days' journey from London, is a fine city with a magnificent cathedral. *Vera Cruz* is its port.

CENTRAL AMERICA.

Originally forming one state under the Spanish crown, known as the kingdom of Guatemala, Central America since 1821 consists of five republics, besides the British territory of Belize or British Honduras (*see* Vol. II., p. 242). Physically, this region resembles the lower and more southern portion of Mexico, having an unhealthy coast with a hot damp climate; lofty mountains, though not of equal altitude with the Cordilleras of the two main continents; numerous volcanoes and a great liability to earthquakes; extensive mineral wealth; and much virgin forest. Coffee, indigo, mahogany, "cedar," rubber, sugar, cotton, sarsaparilla, fustic,

and other dye-woods, cochineal, and tortoise-shell are among the chief exports. The population is about three-quarters Indian or Mestizo, the remainder Spanish creoles. GUATEMALA, the most northernly and most populous republic, extends across the isthmus from the *Gulf of Honduras* to the Pacific. It drains mainly into the Gulf of Honduras by the rivers Montagua and Polochic. **New Guatemala** (*Guatemala la Nueva* or *Santiago de Guatemala*) (71) is the largest town in Central America. SAN SALVADOR, the smallest of these republics, extends 170 miles along the Pacific coast and about 43 miles inland. **San Salvador** (35) is 5,700 miles, or 23 days, from London. HONDURAS extends east and west, south of the Gulf of Honduras to *Cape Gracias à Dios* at the mouth of the *River Segovia*, which divides it from Nicaragua, and touches the Pacific coast between that state and San Salvador. **Tegucigalpa** is 5,930 miles, or 18 days, from London. NICARAGUA, the largest of these republics, extends across the isthmus as it narrows, from the Segovia to the *San Juan River*, which drains *Lake Nicaragua* and separates this state from Costa Rica. One of the proposed inter-oceanic canals utilises the San Juan from *Greytown*, at its mouth, to the lake. **Managua** (20), on the lake of the same name, 5,800 miles, or 25 days, from London, is south of *Leon* (62), the former capital. COSTA RICA, the southernmost republic of Central America, is rich in minerals. **San José** (20), 5,987 miles, or *viâ* New York 21 days, from London, is central in position.

WEST INDIES.

This group of islands has been briefly described in Vol. II., pp. 241–2, especially those islands which belong to Great Britain: Cuba, the largest island and Puerto Rico have since 1898 belonged to the United States; and the possessions of France, Holland, and Denmark in Vol. II., p. 371, and Vol. III., p. 62 and p. 185. SAN DOMINGO, the second largest of the islands, called Hispaniola by Columbus, lying between Cuba and Puerto Rico, contains 29,830 square miles, with a population of 1,700,000. It is mountainous, reaching 8,600 feet, but the mountains are covered with dense forests of mahogany and other valuable timber, and are fertile almost to their summits, so that it was called the "Garden of the West Indies." Coffee, logwood, fustic, cocoa, cotton, tobacco, hides, sugar, honey, wax, mahogany, and tortoise-shell are the chief products. The natives are idle and ignorant negroes and mulattoes. The island is divided into two republics, Hayti and Dominica. HAYTI, the negro republic, formerly French, comprises about 29,000 square miles at the west end of the island, with a population of over a million. **Port-au-Prince** (60), 22 days from London, is a good harbour. The DOMINICAN REPUBLIC, with an area of about 20,000 square miles, in the east of the island, and a population of half a million, mainly mulattoes, was Spanish until 1822. **San Domingo** (16), 4,600 miles from London, on the south coast, founded 1494, has a good harbour.

CHEMISTRY.—VI.

[*Continued from p. 70.*]

AMMONIA—CARBON: THE DIAMOND, GRAPHITE, CHARCOAL, LAMPBLACK—CARBON MONOXIDE—CARBON DIOXIDE—HYDROCARBONS—COAL GAS.

Ammonia (NH_3).—This colourless gas is usually obtained by gently heating a mixture of powdered sal ammoniac or ammonium chloride (10d. per lb.) and quicklime, CaO—

$$\underset{\text{Calcium oxide or quicklime.}}{CaO} + \underset{\text{Ammonium chloride.}}{2NH_4Cl} = \underset{\text{Calcium chloride.}}{CaCl_2} + \underset{\text{Ammonia gas.}}{2NH_3} + H_2O$$

This operation can be performed on a small scale in a test-tube; the pungent smell of the ammonia will be rapidly perceived; its presence can also be detected by holding a piece of moistened red litmus paper at the mouth of the test-tube, when it will be turned blue.

In addition to its pungent odour and its alkaline properties, ammonia is specially characterised by its enormous solubility in water; one pint of water dissolves about 1,000 pints, or 125 gallons of ammonia gas. This solution is the ordinary *liquor ammoniæ* of the shops; the strongest solution is usually known as 880 ammonia, its specific gravity being 0·880 (water = 1).

As the gas is so extremely soluble, it cannot be collected over water, and must be collected over mercury, or by displacement.

A little 880 ammonia (10d. per lb.) is placed in a 4 oz. flask (4d.) fitted with a cork and a straight piece of tube. The flask is most conveniently supported by a wooden clamp (*see* Fig. 22). Over the glass tube is inverted a *perfectly dry* gas cylinder. On gently heating the flask ammonia gas is evolved, and being lighter than air—sp. gr. $NH_3 = \frac{17}{2} = 8·5$, air $= 14·4$ (H = 1) *see* page 1—the ammonia will displace the air, and in a few moments the cylinder will be filled with the gas. If a glass plate be slipped over the mouth of the cylinder, and the latter be placed rapidly mouth downwards

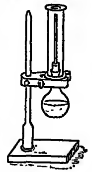


Fig. 22.

in some water, on withdrawing the glass plate the water will rush up and dissolve the ammonia gas.

Ammonia is a powerful alkali or base, and neutralises the strongest acids. If a piece of litmus paper be reddened by an acid, ammonia restores the blue colour immediately; the red spots produced on black cloth by acids disappear instantly (nitric acid stains excepted) when treated with a solution of ammonia in water. A solution of ammonia in water is usually termed ammonium hydrate $NH_3 + H_2O = NH_4HO$.

Ammonia does not burn in air, but it does burn in pure oxygen; when it is mixed with hydrogen or coal gas, the mixture burns in air forming nitric acid, water, etc.

The composition of ammonia can be shown by placing a measured quantity of dry ammonia gas in a endiometer (Fig. 18, p. 68), and passing a series of electric sparks, when the volume of the gas will be seen to increase and eventually to be doubled. Thus, if we start with 20 c.c. of NH_3, we shall obtain 40 c.c. of N and H—in other words the ammonia is decomposed by the sparks into its elements. On page 1 it was stated that a *molecule* of a gas always occupies two volumes, so

$$\underbrace{NH_3}_{2\text{ vols.}} = \underbrace{N}_{1\text{ vol.}} + \underbrace{3H}_{3\text{ vols.}} = 4\text{ vols.}$$

A quantity of oxygen is now added—say 60 c.c., we shall then have 100 c.c. of N + H + O. A spark is passed through the eudiometer, an explosion takes place, and we have left 55 c.c. of N + O, all the H having disappeared with half its volume of oxygen. So that two-thirds of the diminution of volume will give us the hydrogen present. The diminution $= 100 - 55 = 45$, and $\frac{2}{3} \times 45 = 30$ c.c., so that 20 vols. of NH_3 contain 30 c.c. of H and 10 (40—30) c.c. of N, condensed to one-half.

To sum up the properties of ammonia, ammonia is a colourless gas, with a very pungent odour; it is extremely soluble in water; it is usually obtained by gently heating a mixture of ammonium chloride and quicklime; it can also be formed by passing an electrical discharge through a mixture of nitrogen and hydrogen.

The presence of an ammonium compound is usually detected by heating with caustic potash (KHO), when ammonia is evolved with its characteristic odour. The most delicate test for ammonia is, however, the Nessler test, which consists of a solution of mercuric iodide (HgI_2) in potassium iodide (KI), the mixture being made strongly alkaline with caustic potash (KHO). This test solution turns yellow or brown, with exceedingly minute traces of ammonia; when large quantities are present, a reddish-brown precipitate is formed.

Hydrazine.—This is another compound of nitrogen and hydrogen; its formula is $(NH_2)_2$, but little is known of its properties.

Hydroxylamine, NH_2HO, is a powerful reducing agent, and is explosive. Its aqueous solution has been suggested as a photographic "developer."

Carbon (C), at. weight = 12. This element exists in three distinct forms, which are in many respects quite unlike each other, although they consist essentially of the same element (carbon), and when burnt in oxygen produce nothing but carbon dioxide.

There are, in fact, three allotropic forms of carbon (*see* Vol. III., page 321): the diamond, graphite, and the various non-crystalline or amorphous forms, charcoal, etc.

The diamond is the heaviest of the three varieties; it is three and a half times as heavy as water (sp. gr. 3·5); it is the hardest substance known; it is found in India, Brazil, and of late years comparatively large quantities have been discovered in South Africa. The weight of a diamond is always given in carats; 1 carat = about 4 grains. A very fine diamond was exhibited in the Paris Exhibition in 1889, which, when found, is said to have weighed 457 carats; in its present state, cut and polished, it weighs 180 carats, and is worth about £40,000. The origin of the diamond is still involved in obscurity, and it has apparently not yet been prepared artificially. It is often found crystallised, and some of the crystals have curved faces. A comparatively small proportion of the total quantity of diamonds found are transparent enough to be worth polishing for gems. Diamond crystals are usually colourless or pale yellow, sometimes green, brown, blue, or even black. As the diamond is so hard, it can only be cut or polished by means of its own dust. A diamond is first shaped by careful splitting, or by rubbing two stones against each other, the facets are then cut by imbedding the stone in a mass of melted pewter, and pressing it on a rapidly revolving horizontal iron wheel which is moistened with a mixture of diamond dust and oil. The value of the diamond for ornamental purposes is due to its splendid lustre, to its great refractive and dispersive power, by which white light is split up into its constituent colours, and lastly to its great hardness, which enables it to retain its polish unscratched by ordinary dust.

The natural crystals of the diamond are largely used for cutting glass. This property depends on the fact that the edges and faces of the crystals are often somewhat curved, so that we get a curved cutting edge (*see* Fig. 23); the same curved edge is seen on the hard steel wheel of the well known American "glass cutter." Any fragment of diamond

and other dye-woods, cochineal, and tortoise-shell are among the chief exports. The population is about three-quarters Indian or Mestizo, the remainder Spanish creoles. GUATEMALA, the most northernly and most populous republic, extends across the isthmus from the *Gulf of Honduras* to the Pacific. It drains mainly into the Gulf of Honduras by the rivers Montagua and Polochic. New Guatemala (*Guatemala la Nueva* or *Santiago de Guatemala* (74) is the largest town in Central America. SAN SALVADOR, the smallest of these republics, extends 170 miles along the Pacific coast and about 43 miles inland. **San Salvador** (35) is 5,700 miles, or 23 days, from London. HONDURAS extends east and west, south of the Gulf of Honduras to *Cape Gracias à Dios* at the mouth of the *River Segovia*, which divides it from Nicaragua, and touches the Pacific coast between that state and San Salvador. **Tegucigalpa** is 5,930 miles, or 18 days, from London. NICARAGUA, the largest of these republics, extends across the isthmus as it narrows, from the Segovia to the *San Juan River*, which drains *Lake Nicaragua* and separates this state from Costa Rica. One of the proposed inter-oceanic canals utilises the San Juan from *Greytown*, at its mouth, to the lake. **Managua** (20), on the lake of the same name, 5,800 miles, or 25 days, from London, is south of *Leon* (60), the former capital. COSTA RICA, the southernmost republic of Central America, is rich in minerals. **San José** (20), 5,687 miles, or *viâ* New York 21 days, from London, is central in position.

WEST INDIES.

This group of islands has been briefly described in Vol. II., pp. 241–2. especially those islands which belong to Great Britain: Cuba, the largest island and Puerto Rico have since 1898 belonged to the United States; and the possessions of France, Holland, and Denmark in Vol. II., p. 371, and Vol. III., p. 62 and p. 185. SAN DOMINGO, the second largest of the islands, called Hispaniola by Columbus, lying between Cuba and Puerto Rico, contains 29,830 square miles, with a population of 1,700,000. It is mountainous, reaching 8,600 feet, but the mountains are covered with dense forests of mahogany and other valuable timber, and are fertile almost to their summits, so that it was called the "Garden of the West Indies." Coffee, logwood, fustic, cocoa, cotton, tobacco, hides, sugar, honey, wax; mahogany, and tortoise-shell are the chief products. The natives are idle and ignorant negroes and mulattoes. The island is divided into two republics, Hayti and Dominica. HAYTI, the negro republic, formerly French, comprises about 29,000 square miles at the west end of the island, with a population of over a million. **Port-au-Prince** (60), 22 days from London, is a good harbour. The DOMINICAN REPUBLIC, with an area of about 20,000 square miles, in the east of the island, and a population of half a million, mainly mulattoes, was Spanish until 1822. **San Domingo** (16), 4,600 miles from London, on the south coast, founded 1494, has a good harbour.

CHEMISTRY.—VI.

[*Continued from p.* 70.]

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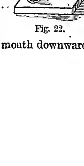

Fig. 22.

Carbon monoxide is a colourless transparent gas which burns with a blue flame, forming carbon dioxide. It is *very poisonous*, and unites with the colouring matter of the red corpuscles of the blood, rendering them incapable of performing their ordinary functions—*i.e.* carrying oxygen from the lungs to the tissues.

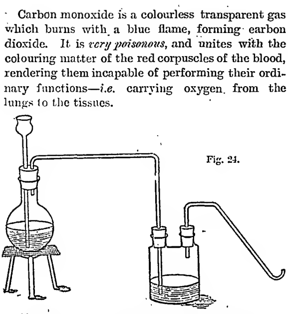

Fig. 24.

Charcoal fires, which produce much CO, are therefore particularly dangerous unless the room is well ventilated.

Carbonic oxide is a powerful reducing agent, absorbing oxygen at a red heat. Thus, when passed over heated oxide of iron, it combines with the oxygen and forms metallic iron—

$$\underbrace{FeO}_{\text{Oxide of iron.}} + CO = CO_2 + Fe$$

Similarly, it reduces the oxides of copper, tin, lead, etc.

Carbon Dioxide or carbonic anhydride (CO_2), frequently but inaccurately termed carbonic acid. This colourless gas is most conveniently prepared by the action of dilute hydrochloric acid upon fragments of marble.

The marble is introduced into a Woulffe's bottle fitted up as in Fig. 5 (Vol. III., p. 322), and the dilute hydrochloric acid is poured down the funnel, when the marble dissolves with effervescence, owing to the escape of carbon dioxide

$$\underbrace{CaCO_3}_{\substack{\text{Calcium carbonate}\\ \text{or marble.}}} + \underbrace{2HCl}_{\substack{\text{Hydrochloric}\\ \text{acid.}}} = \underbrace{CaCl_2}_{\substack{\text{Calcium}\\ \text{chloride.}}} + CO_2 + H_2O$$

The carbon dioxide can be collected over water as usual; it will be found to extinguish a lighted taper, and to be so heavy that it can be poured from one vessel to another. This forms a striking experiment; if a night-light be placed at the bottom of a glass vessel, and a cylinder of CO_2 be poured into the vessel, the invisible gas as it falls will extinguish the light (Fig. 25).

If some lime-water, Ca $(HO)_2$, be diluted with its own volume of distilled water, and a current of carbon dioxide be bubbled through the mixture, the fluid at first becomes milky, owing to the formation of a precipitate of calcium carbonate, but if the current of CO_2 be continued, the precipitate will gradually dissolve, and the liquid will again become clear in consequence of the soluble calcium bicarbonate $H_2Ca(CO_3)_2$ being formed (see temporary hardness, p. 5).

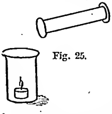

Fig. 25.

Carbon dioxide is evolved whenever any ordinary acid is added to any carbonate. It is also formed in large quantities in lime-kilns, where chalk or limestone is heated to redness—

$$\underbrace{CaCO_3}_{\text{Chalk.}} = \underbrace{CaO}_{\text{Quicklime.}} + CO_2$$

This sometimes leads to fatal accidents; tramps attracted by the warmth take up their night's lodging close to the kiln, during their sleep the wind changes, and envelops them in a current of CO_2, which eventually proves fatal.

Carbon dioxide often accumulates, in spite of the action of diffusion, in old wells, caverns, etc. Before descending a well it is always advisable to let down a lighted candle; if much CO_2 is present, the candle will be extinguished.

The dreaded "choke-damp," which is formed after an explosion of "fire-damp" in a coal-mine, consists to a large extent of CO_2.

One volume of water dissolves nearly two volumes of CO_2; the quantity of CO_2 dissolved can be largely increased by pressure; when the pressure is relieved the excess of gas escapes with effervescence. This is the cause of the effervescence of champagne, soda water, bottled beer, etc. The solution of CO_2 in water is faintly acid to blue litmus paper, and it is supposed that H_2CO_3, the real carbonic acid, is formed—

$$H_2O + CO_2 = H_2CO_3.$$

The reddened litmus paper regains its blue colour when dry.

Carbon dioxide does not burn and does not support ordinary combustion. If a piece of metallic potassium be heated in CO_2, the potassium burns with a red light, forming potassium carbonate (K_2CO_3), depositing black carbon—

$$3CO_2 + 4K = 2K_2CO_3 + C.$$

An atmosphere of carbon dioxide is poisonous, but it acts simply by depriving the lungs of oxygen, and kills in the same way as a rope tightly drawn round the throat. If, however, the quantity of oxygen be simultaneously increased *so as to maintain its normal proportion* of 21 volumes in 100,

an animal can breathe without much discomfort in an atmosphere containing more than 10 per cent. of CO_2. This at first sight seems to clash with the fact that a crowded room in which the atmosphere contains only 1 per cent. of CO_2 is highly injurious, and a great deal of nonsense has been written concerning ventilation as to the deadly nature of this 1 per cent. of CO_2, etc., but the truth is that it is *not* the CO_2, but the organic matter which accompanies it, when the CO_2 is expired from the human lungs, which renders the atmosphere of a crowded room unbearable. This is proved by the fact that pure air containing 1 per cent. of CO_2 can be breathed with but little discomfort: so that the estimation of the CO_2 in a room is only valuable because it is, under ordinary circumstances, an accurate index of the noxious organic matter, whatever it may be, which accompanies the CO_2 in air expired from the lungs of human beings.

Most of the "extincteurs" and other domestic appliances for extinguishing fires contain some substance which readily evolves CO_2. At high temperatures, 1,200 to 1,300° Cent., CO_2 is decomposed into CO and O.

CO_2 is converted into a liquid at a pressure of 38·5 atmospheres at 0° Cent. Liquid CO_2 is occasionally found enclosed in certain minerals. The composition of CO_2 is ascertained by burning a weighed portion of pure carbon, as diamond, in a current of pure dry oxygen, and absorbing the CO_2 formed in a weighed quantity of strong caustic potash solution (KHO) contained in a series of glass bulbs. The increase in weight of the caustic potash gives the CO_2; the loss of weight of the diamond gives the carbon, and the difference between the two the oxygen.

COMPOUNDS OF HYDROGEN AND CARBON, OR HYDROCARBONS.

There are numerous hydrocarbons; for the present we shall only describe three of these bodies: Marsh Gas, Olefiant Gas, and Acetylene.

Marsh Gas or light carburetted hydrogen, CH_4. This colourless gas is prepared by heating in a tube of hard glass—*i.e.*, hard to melt—a mixture of sodium acetate and caustic soda, NaHO—

$$\underbrace{NaC_2H_3O_2}_{\text{Sodium acetate.}} + \underbrace{NaHO}_{\text{Sodium hydrate.}} = \underbrace{Na_2CO_3}_{\text{Sodium carbonate.}} + CH_4$$

Marsh gas has no odour, and burns with a non-luminous flame, forming CO_2 and water—

$$CH_4 + 4O = CO_2 + 2H_2O.$$

It occurs in coal gas, in some coal-mines, enclosed in cavities in the coal, forming the much-dreaded "fire-damp," etc.

Olefiant Gas.—Ethylene or heavy carburetted hydrogen, C_2H_4. This colourless gas can be prepared by heating one part of alcohol with four parts of strong sulphuric acid—

$$\underbrace{C_2H_6O}_{\text{Alcohol.}} = C_2H_4 + \underbrace{H_2O}_{\text{Absorbed by the sulphuric acid.}}$$

Olefiant gas burns with a luminous flame, forming CO_2 and water. It exists to a small extent in coal gas. When mixed with chlorine and exposed to daylight, olefiant gas forms an oily fluid called Dutch liquid, $C_2H_4Cl_2$, hence the name "olefiant" or oil-making gas. When heated to a high temperature it splits up into marsh gas and carbon.

Acetylene (C_2H_2).—This colourless gas is produced whenever coal gas is burnt in an insufficient supply of air; it has a very unpleasant odour. Acetylene is now largely prepared by the action of water on *calcium carbide*, and this convenient method of preparation may lead to its wider use as an illuminant, as the flame is far brighter than that of coal gas. Ordinary combustion is simply the union of substances containing carbon and hydrogen with oxygen, and the terms "combustible" and "supporter of combustion" owe their origin to the fact that we live in an atmosphere containing oxygen;

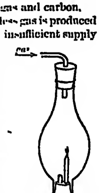

Fig. 26.

if we lived in an atmosphere of marsh gas, oxygen would be called a combustible. A paraffin lamp-glass is closed at either end with a cork, and the corks are fitted up as seen in Fig. 26. Coal gas streams in at the top, and passes out at the bottom by the tube A. Air is gently blown in through the tube B. The lower cork is taken out and the gas lighted, the current of air is turned on, and the cork gently replaced. The air burns with a bluish flame. The coal gas, as it issues from the tube A, has the disagreeable odour of acetylene. Acetylene burns with a smoky flame. It is rapidly absorbed by a solution of cuprous chloride, Cu_2Cl_2, to which ammonia has been added, a brick-red precipitate, $C_2Cu_2H_2O$, named acetylide of copper, being formed.

Coal Gas.—When coal is heated to a red heat in retorts, four chief products are obtained: 1. Coal gas, which is a mixture of many gases. 2. Coal tar. 3. Gas water, which contains much ammonia. 4. Coke.

Purified coal gas contains in 100 volumes 47·5 vols. of hydrogen, 41·5 vols. of marsh gas, 7·8 vols. of carbonic oxide, with 3·0 vols. of olefiant gas, acetylene, and other hydrocarbons, which give to the gas its

illuminating power. Coal is heated to a bright red heat in retorts, the gas and vapours which are evolved are first cooled by passing up and down numerous vertical iron pipes freely exposed to the air ("condensers"), in order to condense the tar and gas water. The gas is then passed through a tower filled with wet coke ("scrubber") which washes out all the ammonia; the coal-gas now contains, in addition to the gases mentioned above, carbon dioxide, sulphuretted hydrogen (H_2S), and other bodies containing sulphur; it is next passed over trays filled with lime, or a mixture of oxide of iron and sawdust ("purifiers"), when the CO_2, H_2S, etc., are to a great extent absorbed. The "gas lime" so produced has an exceedingly unpleasant odour, and is thrown away or used for agricultural purposes. The oxide of iron absorbs the sulphur, forming ferric sulphide—

$$\underbrace{Fe_2O_3}_{\text{Ferric oxide.}} + 3H_2S = \underbrace{Fe_2S_3}_{\text{Ferric sulphide.}} + 3H_2O$$

On exposure to the air the ferric sulphide is decomposed by the oxygen, and ferric oxide, which can be used again, is formed, sulphur being set free—

$$Fe_2S_3 + 3O = Fe_2O_3 + 3S.$$

The constituents of coal gas may be classified thus:—

Illuminants, which give light when burnt, olefiant gas, acetylene, and a little benzol vapour (C_6H_6). These form but three per cent. of the gas. *Diluents*, hydrogen, marsh gas, and carbonic oxide, about 96 per cent.; these give out much heat, but little light. *Impurities*, ammonia and various sulphur bodies.

HISTORIC SKETCHES, GENERAL—I.

THE PERSIAN POWER.

THE very remote history of Persia is involved in much obscurity. The country was most probably, in spite of semi-independence, attached to a neighbouring empire, and certainly in the year 900 B.C. we find it forming an integral part of the Assyrian dominions, and when these fell to pieces Persia did not become free, but was incorporated in the kingdom of Media. The union was not a happy one, and the Persians sought every opportunity to break it off. They found themselves in the position of thralls to men of a civilisation inferior to their own, bound down strictly to religious rules and observances with which they had no sympathy. Even when they had succeeded in inoculating the minds of their masters with their own religion, the magi, the priest-rulers of Media, took upon themselves the administration of the priestly duties, and asserted in the most tender places the right of the strongest to dominate. The religion of the Persians was that which their own prophet or philosopher Zoroaster had taught them more than a thousand years before the birth of Christ. It had in the course of that time become corrupted; upon a comparatively pure system all sorts of gross superstitions, borrowed from the nations with whom the Persians had to do, were engrafted, until the worship of the sun, moon, and stars became a leading feature of the religion. Fire, as symbolising the light of the world, was worshipped by the disciples of Zoroaster, who did not however omit, as their descendants did, the adoration of Him who was symbolised by the fire.

Zoroaster was the first, we might also say the last, who endeavoured to reconcile in his creed the existence of moral and physical evil with the attributes of a beneficent Creator and Governor of the world. "The first and original Being, in whom or by whom the universe exists, is denominated in the writings of Zoroaster, '*Time without bounds.*' . . . . From either the blind or intelligent operation of this infinite Time, which bears a near affinity with the chaos of the Greeks, the two secondary but active principles of the universe were from all eternity produced, Ormuzd and Ahriman, each of them possessed of the powers of creation, but each disposed, by his invariable nature, to exercise them with different designs. The principle of good is eternally absorbed in light; the principle of evil eternally buried in darkness. The wise benevolence of Ormuzd formed man capable of virtue, and abundantly provided his fair habitation with the materials of happiness. By his vigilant providence, the motion of the planets, the order of the seasons, and the temperate mixture of the elements are preserved. But the malice of Ahriman has long pierced *Ormuzd's eggs*, or, in other words, has violated the harmony of his works. Since that fatal irruption, the most minute particles of good and evil are alternately intermingled and agitated together; the rankest poisons spring up amidst the most salutary plants; deluges, earthquakes, and conflagrations attest the conflict of nature; and the little world of man is perpetually shaken by sin and misfortune. While the rest of human kind are led away captive in the chains of their infernal enemy, the faithful Persian alone reserves his religious adoration for his friend and protector, Ormuzd, and fights under his banner of light in the full confidence that he shall in the last day share the glory of his triumph. At that decisive period, the enlightened wisdom of goodness will render the power of Ormuzd superior to the furious malice of his rival. Ahriman and his followers, disarmed and subdued, will sink

into their native darkness; and virtue will maintain the eternal peace and harmony of the universe."

The simplicity of the worship of the Persians is vouched for by Herodotus; indeed, it seems to have impressed all who came in contact with it. "That people," says the Greek historian, "rejects the use of temples, of altars, and of statues; and smiles at the folly of those nations who imagine that the gods are sprung from, or bear any affinity with, the human nature. The tops of the highest mountains are the places chosen for sacrifices. Hymns and prayers are the principal worship; the supreme God, who fills the wide circle of the heaven, is the object to whom they are addressed."

The Median kingdom was not of long duration. Itself originally a province of the Assyrian empire, it shook off the foreign yoke when that empire collapsed, and sprang almost immediately into importance. Allied with the rising power of the Babylonians, it gave the finishing strokes to Assyrian existence, and included within its borders the smaller but still strong province of Persia. Not without the exercise of much cruelty, and the exhibition of a ferocity which betokened the barbarian, were the Persians subdued; and it is probable that at no time was the country completely under subjection, unless it might be in the plains and lowlands, the warrior caste and the princes preserving in the highlands the spirit and even the form of independence. The Medes were almost afraid—they had good reason to be so—of the acquisition they had made. They saw in the superior intellects and greater knowledge of their subjects the signs of a power that might one day prove fatal to their rule, and they endeavoured by all the means at their disposal to conciliate them, though not till after they had made irreconcilable enemies of them. The Persians temporised, waited for their opportunity, and never ceased, while yielding nominal allegiance to the Mede, to look forward to the day when the tables should be turned, and when the one pure religion and the one Aryan (nobler) race should be acknowledged as supreme.

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"Crownless and sceptreless Belshazzar lay,
A robe of purple round a form of clay."

Cyrus, under the direction of his uncle, Cyaxares. II., who had accompanied the army, took military possession of the famous city, and having made it as strong as possible went back to Persia, laden with the almost fabulous wealth which successive Babylonian kings, notably Nebuchadnezzar, had accumulated. Cyaxares, anxious to secure the benefits of so fine a city, and glad of an opportunity which gave him, a Persian, the means of eradicating from the Median mind that there was any actual necessity for governing from their capital, moved the seat of his government to Babylon, a situation which also afforded a better base for those military operations which he contemplated against several other of the Eastern monarchies. Soon after this removal occurred the remarkable incident chronicled in the book of the prophet Daniel. The Persian king, called in the prophet's writings Darius, a title common to all the Median princes, and meaning simply "the king," began to persecute the priesthood which he found in Babylon. The Persians, as the worshippers of one God, and as followers of the simple and pure faith of Zoroaster, were extremely averse to the complicated and degrading superstitions which were common in all the countries around them. It had been the most galling part of their bondage to the Mede, that they had to submit to the interference of a powerful priesthood, which dominated to the exclusion of all that was noble and admirable in the national mind, and which sought only to establish its own power at the expense of whatever else might come in its way. Cyrus and Cyaxares, for the latter now associated his nephew in the government which that nephew had originally handed over to him, never lost an opportunity of showing their contempt and hatred for professional priesthoods and for the superstitions they taught. In Babylon they found a superstition and a priesthood worse than those of the Median magi. They determined, both as a matter of policy and morals, to insult the power which held the people in awe, a power which, as they well knew, might at any time cause an insurrectionary spirit to spring up among the people, and which from their hearts they despised as being based upon imposture, ignorance, and falsehood. Among the prisoners at Babylon was a man, one out of thousands, to whom the Persian princes were drawn at once by the force of a religious and intellectual sympathy, as well as by his personal merits. Daniel, the prophet of the one God, the man who had dared even Belshazzar's wrath in testifying against the wickedness of Babylon, and in asserting the only adorable Jehovah, was the man whom Cyaxares singled out to help him in governing the new kingdom and in overthrowing the priesthood. The Persian and the Hebrew worshipped one God, though in different ways; and though the latter deemed it essential to proper worship that the service of God should be splendid and served by an exclusive priesthood, while the former held simplicity of worship without the intervention of priests to be the more acceptable sacrifice, yet the conditions under which the two met in Babylon prevented any clashing in this regard. Daniel was an exile, a fugitive, singing the Lord's song in a strange land, remote from Jerusalem, "where God ought to be worshipped," away from the possibility of partaking in those ceremonies and ritualistic performances which the Jews had been taught to look upon as so well-pleasing to God. Whatever he may have longed for, he could not at Babylon either celebrate or partake in any ceremonial of Jewish worship which might affront his new master. His prayers, his way of making his wants known to God, and his mode of worship, must have been as simple and unaffected as those of Cyrus himself. He was an alien, it is true; but so were the Persian princes themselves aliens, not only among the Babylonians whom they had conquered, but also among the Medes by whose arms they had conquered. Herein was another bond of union. So Daniel was promoted to honour, apparently to the rank of grand vizier, in the Persian court. Cyrus was gone on military expeditions which took him to Egypt and to Syria; Cyaxares ruled alone, with the help of such assistance as the Hebrew prophet gave. We may reasonably suppose that some popular outburst of feeling on account of the priesthood, some fanatical piece of enthusiasm of the priests themselves, led him in a moment of contemptuous anger to issue the famous decree that "whosoever shall ask a petition of any God or man for thirty days," save of the king, should be cast into the den of lions. The sequel is well known; the sorrow of Darius when he found where the punishment fell; the endeavours he made "till the going down of the sun to deliver him;" the envious insistence of the Median and Persian princes upon the law of the Medes and Persians which altereth not; and how "the king commanded, and they brought Daniel, and cast him into the den of lions." The religious sympathy between the king and his great subject, the common belief they had in the might and goodness of a God who was King of kings and Lord of lords, was distinctly and clearly shown in the speech of Darius: "Thy God whom thou servest continually, he will deliver thee."

Soon after the delivery of Daniel from the lions'

into their native darkness; and virtue will maintain the eternal peace and harmony of the universe."

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shadowing a power as that wielded by the Persian king, and they used every opportunity of carrying out this policy. Wars frequent and bloody were the consequence, and the strength of Persia, crippled as it was by Miltiades at Marathon (B.C. 490), was gradually undermined. As the inferior civilisations had given way to the Persian, so that was now to give way to the superior civilisation of the Greeks. Prodigious as the efforts of Xerxes, the successor of Darius, were, enormous as were the cost and equipment of his fleets and armies, they failed to make an impression upon the rock-founded states of Greece. Xerxes himself, after collecting such armies as had never before been heard of, after three years spent in preparations against the inevitable, returned home covered with disgrace; and the army he had left to cover his retreat, and to make a show of military dignity in retiring, was completely destroyed at the battle of Platæa.

From that time the Persian power declined. Artaxerxes, the successor of Xerxes, who was murdered by his guards, for a few years revived the fading splendour of the empire; but he likewise in the end passed under the waters of adversity, and was compelled to sign treaties which Cyrus would not have touched with the tip of his sword. Another hundred years of fitful existence, and then the end came. Alexander of Macedon, gathering the reins of all Greek government into his own hands, was the incarnation of all that was strongest and wisest in the counsels of nations. At Issus and Arbela he completed the work which Miltiades began; and three hundred and thirty years before Christ, the Persian power, which had been all but universal, was laid low by those who in turn succumbed to the Latin race they once affected to despise.

See:—Cassell's Universal History.

LATIN.—XXI.

[*Continued from p. 79.*]

ORDER OF WORDS AND CLAUSES.

§ 12. It is at once apparent that a language which, like English, has lost almost all inflections, has also lost for the most part that liberty in the arrangement of the words composing the sentence which belongs to all inflectional languages.

It is obliged to adopt a much more rigidly fixed order, inasmuch as the place which a particular word occupies in the sentence is usually, if not always, the only indication that can be given of the place which it occupies in the thought of the speaker or writer in relation to each other word in the sentence. For instance, it is only possible to distinguish by the order in which they are expressed two such important elements in the thought as the subject and object. It is essential that each should occupy the particular place which custom has assigned it. Reverse the order and you reverse the thought.

But in an inflected language it is logically possible for all the main elements of the sentence to occupy any place in the sentence, to be arranged in any order. The inflections show immediately what is the logical place—the place in the thought of the writer—that belongs to each of them in relation to all the others.

It is the *form* of the word, and not its *position* in the sentence, that defines its meaning.

For instance, in order to express in English the thought, "Brutus killed Cæsar," we must use that and no other order of the words. But Latin is enabled to mark by inflections the logical relations of the words, and can write either *Brutus occidit Caesarem*, or *Caesarem occidit Brutus*, or *Occidit Brutus Caesarem*; in short, can place the words in any order.

Indeed, there are only a very few words in Latin which are in any way confined to or excluded from particular places in the sentence. Of such are:

(*a*) Those which *usually stand first:* viz.—

(1) Conjunctions (Co-ordinate and Sub-ordinate).

(2) Relative Pronouns.

(3) Interrogative Pronouns and Adverbs;

(*b*) Those which *usually do not stand first:* viz.—

(1) Enclitics and Indefinite Pronouns.

(2) *Vero, autem, enim, igitur* (usually *second*); and *quoque, quidem, tamen* (which follow the word they emphasise).

[Even of these, all under (*a*) may be forced to yield precedence to some particularly emphatic word.]

With these exceptions Latin enjoys complete freedom of choice in the matter of *order*.

But it must not be thought that this liberty makes the writing of Latin easier, and that the choice is a matter of indifference.

On the contrary, as we have already noticed, it is just by the order of the words in a sentence that Latin succeeds in producing its most emphatic and vivid and simple effects. If we would write Latin, we must carefully and closely observe the manner in which the best Latin writers build up their sentences, until we are able to *feel* the force of the order of every word. It is mainly a matter of feeling. But that is only to be acquired by most of us after we have read and re-read a good deal of the best Latin, and meanwhile there are a number of general rules that can be laid down for our guidance. We need only note for the most part variations from the usage of English.

(i.) First and most important of all rules, we

must always remember to reserve for the end of the sentence some word which is essential to the completion of the sense. It must not be possible for us to stop in the middle of the sentence under the impression that there is nothing more to come, that the sentence is finished. We must always be kept waiting till the very end for some important word, without which the sense would be incomplete. Of course the effect of this is by no means to give us the sensation of being kept waiting, and so of the sentence "dragging." Rather, we are hurried along to the end, and our attention is more fully sustained; so that, though the arrangement seems to us somewhat artificial, its general effect is forcible and vivid.

(ii.) The next chief general rule to be observed is to place in close proximity the words which are most closely related in logical connection.

In considering the structure of the sentence (*vide* § 7), we saw how the shortest form of a simple sentence containing a subject, a verb, a direct object, and an indirect object could be expanded by the addition of qualifying words and phrases to each of these elements of the sentence. In a Latin sentence all such qualifying additions—whether, as in a simple sentence, they remain as adjectival or adverbial epithets, or, as in a compound sentence, assume the form of subordinate adjectival or adverbial clauses—must be placed in immediate proximity to the words which they qualify. It is needless to point out how much additional clearness Latin gains by the observance of this logical order.

(iii.) The emphatic positions in the sentence are the beginning, which rouses attention to what is to follow, or marks its connection with what has preceded, and the end, which, as we have noticed, must be reached before the sense is completed. The first and the last place retains each its respective importance and emphasis alike in the whole sentence, and in each subordinate clause of which it is compounded.

§ 13. These three general principles being premised, we may sum up the chief points to be observed in the order of words in a Latin sentence (where it differs from English) as follows:—

1. The Finite Verb generally stands last (and therefore all oblique cases* of nouns and pronouns, adverbs, and adverbial phrases, *precede* the verb with which they are connected).

2. Adjectives and adjectival phrases (such as the Genitive of a noun) generally *follow* the noun which they qualify.

But adjectives of Number and Quantity, and some demonstrative pronouns—*e.g.*, *hic*—*precede* as in English.

3. In cumulative phrases—that is, phrases in which a number of ideas are "heaped" together around one main idea to further define it, these additional complementary ideas are worked up, if possible, into the middle of the main phrase, the most important word in which is reserved for the last place—*e.g.*, in a phrase composed of a noun and an adjective (or its equivalent), and other complementary words, the usual order is Adjective, Complements, Noun: *e.g.*—

Great bodily pain.
Ingens corporis dolor.

Extraordinary courage in the midst of danger.
Mira in mediis periculis virtus.

With the applause of all wise men in all parts of the world.
Cum omnium omnibus in terris sapientium favore.

Such is the *natural*, or at all events, the *normal* order of the different component parts of the sentence. Any departure from this order attracts particular attention to the words thus detached from their natural position. And so we have ready to hand an easy means of emphasising any word or phrase we wish to emphasise, and of producing slight differences of meaning by slight changes of order. We have, that is to say, in this power of varying the order (itself largely, as we have seen, the result of inflections), an instrument for ringing changes of meaning which can only be expressed in English by more or less roundabout devices.

To take a simple instance: *The Gauls took Rome* would generally be in Latin *Galli Romam ceperunt.*

But out of the same Latin words we can get the following differences of meaning:—

It was the Gauls that took Rome.	Romam ceperunt *Galli.*
It was Rome that the Gauls took.	*Romam* Galli ceperunt.
The Gauls *actually took* Rome.	*Ceperunt* Galli Romam.

Similarly, for instance, by placing adjectival or adverbial phrases at the beginning or end of the clause, we make them specially prominent and emphatic: *e.g.*—

Aeternam nascimur in vitam.
We are born to life *eternal.*

Puerum verberavit *crudeliter.*
He beat the boy pitilessly.

Capta est Troja *causa Helenae.*
It was for the sake of Helen that Troy was taken.

Regnavit illa *quinquaginta annos.*
Fifty years she has reigned.

§ 14. The following exercise will give the student an opportunity of practically applying these rules. Before beginning it, he should also carefully read over again the sections dealing with the most characteristic differences between English and Latin, and the special modes in which the latter

* The direct object is usually placed nearest to the verb—that is, after the indirect object.

attains its special clearness and precision (simple, direct, personal, concrete):—

Claudius, after receiving this intelligence, set out for Rome at once. I shall be delighted to come with you to-morrow, if you ask me to dinner. Those two famous liberators of their country died on the same night. A fierce battle was begun, attended by heavy losses on both sides. A whole winter's complete rest made them ready to endure everything afresh (*ad* with the gerundive). As the barbarians now displayed less energy in their attacks, a junction of the forces was effected on the following day, and the pass was left behind, not without bloodshed, but with more loss of horses than of men. A Roman citizen has no fear. We have no other hope of safety. It is said that he often displayed real magnanimity towards his opponents. He not only killed the men he had conquered, but also seized their land, which had been already laid waste with fire and sword. Two trusty slaves were sent to Agrippa with a letter. This opinion was expressed by Cicero during his consulship, but before he held office he used to act quite differently. Augustus himself was almost inconsolable after the loss of Marcellus. They are sending Drusus to Africa with a general promise of pardon.

We have noticed how, in a connected piece of narrative, English prefers a number of short coordinate sentences, while Latin builds up the whole into one compound sentence with subordinate clauses arranged in logical order. If our English sentences are not really independent of one another in thought, we must find out the main idea conveyed in them, and express that as the principal sentence, and build up the accessory ideas around it. The following passage should be dealt with in this way. The main idea to be conveyed is that Hanno remained with the enemy:—

Hanno thought that he would effect something by entreaties. So without letting the Carthaginians know, he crossed over to Flamininus in the night. His tears, however, effected nothing, and harsh conditions of peace were offered, as might have been expected from (*ut ab* . .) an angry foe in the hour of his triumph. So he gave up his pleading, and remained with the enemy transformed from an ambassador into a deserter.

USE OF THE MOODS.

§ 15. In some of the examples already given in these lessons, we have been obliged to make some use of all the moods of Latin. We must now endeavour to distinguish carefully between the usages of each.

The INDICATIVE need not delay us long. It is the mood which is used, alike in principal and in subordinate sentences, whenever we wish simply to make a direct statement, without adding to it any thought of our own, or of anyone else's about it. We simply narrate the occurrence, or the fact, or the thought, as such; we do not (unless, indeed, we are speaking of ourselves) vouch for or qualify it in any way.

The IMPERATIVE similarly expresses direct command, and needs no comment. It is, however, but little used in Latin, the *jussive subjunctive* or some periphrasis usually taking its place.

The INFINITIVE, in most of its usages, is rather to be classed with nouns than with verbs. We need only here note its employment to express in *Oratio Obliqua* the principal verbs of *Oratio Recta*, whether these principal verbs were in the indicative (as usual), or in the subjunctive (as, *e.g.*, the apodosis of some conditional sentences); while the nominative or subject of *Oratio Recta* becomes the accusative (with the infinitive) in *Oratio Obliqua*.

The SUBJUNCTIVE, however, especially as being a mood almost unknown to modern English, requires particular attention on the part of every student of Latin. It has been truly said that an intelligent and correct use of this mood is one of the best tests of knowledge of Latin syntax.

The name of the mood would imply that it was only used in subordinate clauses, subjoined to other more independent sentences. But though it is perhaps most generally found in such dependent clauses, it has no exclusive possession of them (the indicative being used in many kinds of subordinate clause), and is also frequently used as an independent mood in principal sentences of all kinds—statement, question, and petition—with the peculiar shades of meaning which we can express as follows:—

SUBJUNCTIVE IN PRINCIPAL SENTENCES.

§ 16. (i.) STATEMENT (*Potential Subjunctive*).—The subjunctive differs from the indicative in making the statement less directly and bluntly, with a certain manner of hesitation and uncertainty. It is thus used mostly with the first person, or with the indefinite second and third persons ("you" and "someone" not particularising individuals, but meaning "anyone"), and represents the English "may," "might," "would," "could," "should": *e.g.*—

I could wish it were so.
Velim haec ita esse.
You would have believed he was mad.
Crederes eum dementem
Perhaps someone *may say*.
Dicat (or *dixerit*) aliquis (or quispiam).

(ii.) QUESTION (*Deliberative Subjunctive*). — Similarly the subjunctive asks a question with some

degree of doubt, astonishment, or perplexity. It is often simply a more colourless—less vivid and less direct—expression for the future indicative. And it may be noted that such questions are for the most part what are called "rhetorical" questions, not asking for information nor requiring an answer, but serving as a device to attract attention: *e.g.*—

> What *am I to ask for?*
> Quid *poscam?*
> Who *would have dared* to say this?
> Quis hoc dicere *auderet* (or *ausus fuisset*)?
> Who *would do* so?
> Quis haec *faciat?*
> What answer *were you to give?*
> Quid *responderes?*

(iii.) PETITION (*Optative or Jussive Subjunctive*).—The subjunctive is also the regular mood for expressing a wish (often with *utinam* prefixed), a command, or an exhortation.

The negative of such petitions is expressed by *ne*: *e.g.*—

> God forbid!
> Di omen *avertant!*
> May we die at home!
> Utinam domi *moriamur!*
> Let him not go out.
> Ne *exeat.*
> Do not say this or that.
> Ne *dixeris* hoc neve illud.
> I wish I had been safe in Rome!
> Utinam Romae salvus *essem* (or *fuissem*)!

§ 17. The following exercise contains examples of cases in which the independent subjunctive should be used to express the English indicative, and also some instances in which English uses the subjunctive (or potential) mood, and Latin the indicative (*e.g.*, using the modal verbs *possum*, *debeo*, etc., with the infinitive).*

What is to become of me? What ought I to have said? I would not venture to do such a thing. I wish I had never been born. I could have wished for nothing better. What is he to believe about his brother? What will you believe next? It would be tedious to tell you everything. It would have been better to have said so at once. Whoever he be, they should not have accused him in his absence. He might have easily escaped, but he would not make the attempt. Would you dare do such a foolish thing? May I never reach old age! You would think that a strange wish. I may assert that that is a false opinion of yours. Let not the enemy devastate the whole of Greece. Do not blame anyone for your own mistakes. Am I to suffer thus in my old age? Could he not have shown mercy in the hour of his triumph to the friend of his boyhood?

* Cf. § 6 *supra* as to the precision that marks the Latin use of tenses.

KEY TO EXERCISE (p. 76).

Se illum in summo monte occisurum (esse) minatus est. Litteras a te accipere jamdudum cupimus. Dicitur insula capta illum magno dolore affecisse. Domum cras redibo. Tres muri urbem tum firmabant. Imprudens id fecisse visus est. Aperte adulantem nemo non odit. Laetus hoc dicam, si tu solus recusabis. Puero illi vitam beatam parare multo facilius fuit. Pro patria caput libens obtuli consul. Virum fortissimum me fuisse omnium judicio constat. Sed beneficii mei immemores omnes fuerunt. Novam hominum gentem petam, qui viros fortes patriaeque studiosos adhuc mirantur. Jam absentem me desiderabunt; sed, ubi gratos amicorum animos expertus ero non me in medios invidos malevolosque rursus conferam. Tradunt post Ciceronem mortuum neminem oratorem summum apud homines exstitisse.

KEY TO TRANSLATION FROM PLINY (p. 78).

When the evening began to approach, he orders (a couch) to be arranged for him in the front part of the house, he asks for writing-tablets, a pen, and a lamp; he sends all his household to the inner parts (of the building), and devotes himself, (with) thought, eyes, and hand, to writing, lest his mind (if) unoccupied might imagine the ghosts he had heard of and form groundless fears. At the beginning there was (only) the silence of night, as there is everywhere; after that iron is rattled, chains are moved. He did not lift his eyes, did not put down his pen, but strengthened his resolution; then the noise increased, came nearer also, and was heard as if already on the threshold, now as if within the threshold; he looked back, sees and recognises the form he had been told about. (The ghost) stood and beckoned with his finger, as if he were calling; he, on the other hand, signed with his hand (to it) to wait a little, and again applied himself to his tablets and pen. The ghost rattled his chains over the head of the writer; he looks back again, and sees it beckoning in the same way as before; he, without delay, takes up the lamp and follows it. The ghost went at a slow pace, as if burdened with chains; after it had turned into the court of the house, it suddenly sank (into the earth), and left its companion; he, left alone, places grass and leaves that he plucked to mark the spot. Next day he visited the magistrates, and tells them to have that spot dug up. Bones are discovered inserted and enveloped in chains, and the body, which had been rotted by time and the soil, had left the bones bare and eaten away by the chains; they are collected and buried at the state expense. Henceforth the house was freed from the spirit duly laid to rest.

HYDRAULICS.—I.

INTRODUCTION.

THE term *Dynamics* embraces the whole subject of the application of Force to Matter, and is usually divided into two branches. The science of the balancing of forces is called *Statics*, and the subject which treats of forces acting on matter so as to produce motion or change of motion is called *Kinetics*. Hence *Hydraulics*, which is the term generally applied to the behaviour of Water under the action of forces, whether these forces produce rest or motion, is divided into Hydrostatics and Hydrokinetics.

The general heading *Hydrodynamics*, including the study of Newton's laws of motion in their

application to fluids, is also naturally divided into Hydrostatics and Pneumatics, according as these laws of motion are applied to the two kinds of Fluids—namely, Liquids and Gases.

PROPERTIES OF FLUIDS.

Solid and Fluid Bodies.

Every person is familiar with the fact that a *solid* body, such as a lump of stone or iron, has a definite shape, and offers permanent resistance to change of form. On the other hand, a *fluid*, such as water, cannot be said to possess any definite shape, except that of any vessel into which it is poured, and it may be easily changed in form by the application of slight force, since the particles move freely amongst one another and cannot offer any frictional resistance to such sliding. In short, a solid has rigidity or resistance to change of form, whilst a fluid has no unyielding rigidity.

Flow of Metals.

Malleable and ductile metals, such as steel, copper, tin, and lead, may be made to flow, without being melted, and without loss of their strength, when sufficient stress is gradually applied to them. Hardened steel can be drawn out through a die into pianoforte wire, or spread out like dough under a roller, and its elastic strength may be even improved thereby. Copper can be beaten out into any desired shape, or squirted through a hole like macaroni when subjected to great pressure. It can also be drawn out into extremely fine wire. As a rule, the harder the metal the more slowly must these operations be performed so as not to injure its strength. This flowing of metals is very different from the flowing of a fluid, such as sealing-wax, pitch, tar, and honey.

Viscosity.

Pitch is a rigid-looking, black, bituminous material, which splinters when hammered, and yet under the action of its own weight it flows very slowly like a liquid. If a lot of pitch blocks, somewhat resembling coal, be thrown up in a heap, it will be found after a few days to have flattened down into one mass, and will continue spreading out into the containing vessel or room, just like a liquid, until it finds lateral support. Again, a long stick of sealing-wax supported only at its ends slowly bends down and flows under the action of its own weight. Liquids such as tar and honey also oppose considerable resistance to a *sudden* change of form produced by a spoon or knife moving through them, and are said to be *viscous*. Water also possesses this property, though to a much less degree, since it yields more readily than any of the above substances to slight stresses tending to make it change its form. In fact all *real* fluids possess a *yielding rigidity*, which though incapable of preventing change of form, offers resistance while the change is being produced. *This yielding rigidity is called viscosity or viscidity.*

It diminishes with the relative motion of the different parts of a fluid, and is found to be directly proportional to the rate of change of form. This viscous resistance to motion must be distinguished in the first place from the resistance to change of form offered by a ductile metal, because the latter does not vary in the same way with the quickness or slowness of such change. The resistance in a metal does not vanish for very slow changes of form, and is not exceedingly great for very quick changes of form. Thus bronze brackets with straight edges, and having objects lying on the top of them, discovered in Pompeii, have not been altered or changed in shape after many years, notwithstanding the constant pressure to which they have been subjected. In the second place, fluid viscidity is different from the resistance to change of motion of a mass, as a whole, possessed by fluids in common with all bodies. The latter is simply the resistance which any body offers to being suddenly and rapidly set in motion. On account of this resistance, a cannon-ball fired at sea rebounds from the water, whilst, on the other hand, the constant frictional resistance experienced by the skin of a ship in its passage through the water at a uniform velocity is mainly due to viscosity.

Measurement of Viscosity.

The relative viscosities of different fluids, as air, water, and oil, may be measured by the effect which the frictional resistances have in stilling the vibrations of a metal disc when vibrating in each fluid. A heavy disc or short cylinder of brass is suspended by a long wire in the centre of a much larger vessel filled with the fluid. A long light pointer is fixed to the wire above the vessel. When the suspension wire is twisted round through half a turn and then let go, the disc will vibrate backward and forward. The total amplitude of swing or angle turned through by the pointer will gradually diminish, and the rate of diminution of swing, or stilling of the vibrations, gives the viscous friction of the fluid. In air the vibrations go on for a long time, especially when they are slow and of great amplitude at the start. The disc vibrating in oil is brought to rest more quickly than when in water, showing that the viscous friction of the oil is the greater. The relative coefficients of viscosity, thus measured, enable us to arrange fluids in a regular graduated series from air, which is practically frictionless for very slow motion in it, up to oil,

honey, tar, and the more viscous mixtures of tar and pitch.

Experiment shows the force of friction in fluids depends very much on the velocity. It is exceedingly small and proportional to the speed when this is very slow, but it increases much more quickly than the speed, being proportional to the square and even cube of the velocity when this is very great. Thus the force of friction is proportional to the *square* of the velocity in the case of ordinary steamers; that is to say, if one steamer goes *twice* as fast through the water as another, the high-speed one will encounter about *four* times the frictional resistance offered to the slow-speed steamer. In the case of air, the frictional resistance to the motion of a rifle bullet is proportional to the cube or higher powers of the velocity. A rifle bullet going through the air at twice the usual velocity is hindered by (2^3), two cubed, or eight times the frictional resistance from the air that it would meet with at the ordinary velocity.

Again, the *force of fluid friction*, unlike that of solids, *is independent of the pressure* to which the fluid is subjected. The stilling of vibrations in the above experiment is the same even when the liquid is placed in the receiver of an air pump.

Professor Perry has designed the apparatus Fig. 1

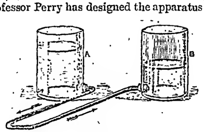

Fig. 1.

to show that the friction of liquids flowing *through* a pipe is independent of the pressure.

The U-shaped tube connecting the two vessels may be much longer than that shown in order to offer a great resistance compared with that of its joints and bends. With a given *head* or difference of level of the free surface of water in the vessels A and B, it is found that a certain quantity of water takes the *same time* to run through from one vessel A to the other B, and restore equality of level in all cases, whether the tube is in the position shown in Fig. 1 or in the position Fig. 2, or when the tube is standing in a vertical plane and acting as a siphon. It follows that the *fluid friction must have been the same* in all cases throughout the experiment, since the same quantity of water passed through the tube per second; for if not, the velocity of flow would have varied as well as the time required to restore level. Now the *pressure* of the water at any given point in the tube is different in each position, being very much greater in the position Fig. 2 than in the position Fig. 1, because the heights of the free surface of liquid in the vessels above any particular point in the tube is greater, although the

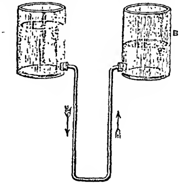

Fig. 2.

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Again, experiment shows that the force of *fluid friction is directly proportional to the area of the wetted surface* where friction occurs; also, for moderate velocities of flow, the friction does not seem to depend on the nature or roughness of the wetted surfaces. This may be due to the fact that a layer of fluid gets plastered on the solid surface, adheres to it, and thus moves with it through the rest of the fluid. The frictional resistance offered to the disc vibrating in the fluid is found to remain practically the same even when the disc is indented. In this respect, the force of fluid friction is very different from that between solids, which is well known to vary very much with the nature and roughness of the rubbing surface. Thus we are all familiar with the fact that the frictional resistance to motion between perfectly smooth ice and skates is very much less than that offered by rough ice and a rough piece of steel.

LIQUIDS AND GASES.

Fluids are divided into two great classes—*liquids*, or incompressible fluids, and *gases*, or compressible elastic fluids.

When liquids are subjected to very great pressure they yield and diminish a very little in volume, so that, strictly speaking, liquids will not absolutely refuse to occupy a smaller space at constant temperature. When water is subjected to pressure it yields, and diminishes one-twenty-thousandth part or ·00005 of its total bulk for an increase in pressure equivalent to one atmosphere. In other words, if the ordinary atmosphere be removed by

an air pump, and the pressure on water reduced to zero, the water dilates, and its bulk increases ·00005 of its total volume. Hence, also, at five miles deep in the sea, the diminution in volume is such that a cubic foot of water would be about 4 per cent. heavier than at the surface. Sea-water weighs about 64 pounds per cubic foot, and pure fresh water 62·4 pounds at 4° Centigrade or 39° Fahrenheit. This diminution in bulk under great pressure is thus so very insignificant that for all practical purposes water may be considered incompressible. Even in hydraulic machines working with water at enormous pressure, the change in bulk is practically imperceptible and negligible.

On the other hand, *gases* yield to the smallest increase of pressure. When kept at *constant temperature*, one cubic foot of dry air under ordinary atmospheric pressure becomes reduced in bulk to half a cubic foot under double the pressure, and is compressed into the quarter of a cubic foot by four atmospheres' pressure; the *volume always varying inversely as the pressure.* Not only so, but the smallest quantity of air is capable of expanding so as to occupy any vessel however large, and may be found in every part of it.

We observe that liquids can form into drops, and possess cohesion and resistance on their free surface as if surrounded with an elastic skin, due to what is called surface tension. Gas is remarkable for the absence of all apparent cohesion. In fact, gaseous particles seem to repel one another, fly about in all directions, and bombard the walls of the containing vessel, thus producing elastic force or pressure of equal amount in every direction. Hence, a given quantity of gas cannot be said to have either a definite shape or volume, because both will vary with the containing vessel. So that when we wish to know the quantity or mass of gas which occupies a given volume, we shall find it is necessary to specify the pressure under which this volume is measured as well as the temperature of the gas.

Weight and Pressure of Air.

We shall also find by experiment that gas, in common with all kinds of matter, possesses *weight*, and is acted on by the downward pull or attraction of the earth, according to Newton's universal law of gravitation. We do not usually feel the weight of the air in which we live and move simply because it presses on us equally in all directions, unless when there is a wind caused by unequal pressure or other atmospheric disturbance.

One cubic foot of dry air at 0° C., and under atmospheric pressure, weighs about 0·0807 pounds. In more exact calculations it is usual to take a litre or 1,000 cubic centimetres of dry air at 0° C. and under pressure of 76 centimetres of mercury, as weighing 1·2932 grammes. Under these standard conditions, namely, at 0° C. and pressure of 76 centimetres of mercury, hydrogen gas weighs 0·0896 grammes per litre or 0·00559 pound per cubic foot.

The atmospheric *pressure* is equal to that of a column of mercury 30 inches high. Now mercury is 13·596 times heavier than water, therefore the ordinary atmospheric pressure is equivalent to that of a column of water 13·596 times as high as the mercurial column, that is, $\frac{30 \times 13{\cdot}596}{12} = 34$ feet nearly. At the ordinary temperature we may take this pressure as equivalent to 14·7 pounds on every square inch of surface.

Exercise.—The atmospheric pressure will support a column of water nearly 34 feet high; express this pressure in pounds per square inch of surface; given that a cubic foot of water weighs 62·4 pounds.

Liquefaction of Gases.

All bodies assume the gaseous state when heated to a sufficiently high temperature. We are familiar with water both in the solid state as ice and in the gaseous state as steam; the change from the one state to the other depending on the temperature and pressure. Liquid water boils when the pressure of its vapour overcomes the superincumbent atmospheric pressure. Liquid ether, when poured out on the hand, rapidly evaporates. Now if we enclose this ether vapour and a little of its liquid in a glass tube over mercury, and allow it to occupy a large volume at small pressure, whilst the temperature is kept constant throughout the experiment, as we gradually diminish the volume the pressure increases up to a certain point, depending on the temperature, when the vapour condenses. On further diminishing the volume, the pressure remains practically constant until all the vapour is changed into liquid. If we then try to diminish the volume still further we find great resistance offered, and the pressure rises suddenly. If we repeat the experiment, keeping the glass tube and its contents at a higher temperature, on diminishing the volume we shall find another definite constant pressure at which liquefaction takes place.

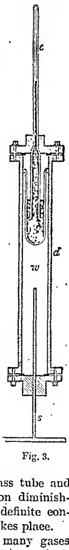

Fig. 3.

Faraday succeeded in liquefying many gases

honey, tar, and the more viscous mixtures of tar and pitch.

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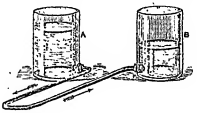

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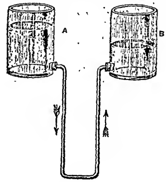

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any evidence of actual liquefaction. At higher temperatures this bend or flexure in the pressure-curve gradually disappears; and at 48·1° the curve is perfectly regular, like that of air seen to the right hand corner of Fig. 4.

CRITICAL POINT.

At all temperatures *above* 30·92° C. (87·7° Fahr.) carbonic acid remains a gas and cannot be liquefied by any pressure, however great; so that the region to the right of the curve for temperature 30·92° C. represents the perfectly gaseous state. On the other hand, at temperatures below 30·92° C. carbonic acid can be reduced to the liquid condition by applying pressure above a certain limit indicated on the curve A A' P for different temperatures. At pressures above this both liquid and gas are distinctly visible in the tube, and the boundary between them is sharply defined. Now, as the temperature 30·92° C. is reached, the density and other properties of the liquid and gas become nearly alike, until finally they merge into one another at P and 30 92° C., and cannot be distinguished at any higher temperature

This point P has been called by Andrews the *Critical Point*, and 30·92° C., the *Critical Temperature* for carbonic acid.

Further experiment shows that if carbonic acid gas at 31° C., or well above its critical temperature, be raised in pressure to, say, 100 atmospheres, and then gradually cooled, at this pressure, below the critical temperature, the substance will pass from the gaseous to the liquid state *without any abrupt change or break in the continuity*, but the carbonic acid may now be proved to be in the liquid state, for by taking off the pressure an abrupt change from liquid to vapour is seen by the liquid actually boiling.

Also at the critical point P, Fig. 4, when the carbonic acid occupies a definite volume under definite pressure, and at 30·92° C., the thermometer tube *c* is found to contain a homogeneous fluid which cannot be called either a liquid or a gas, and is really in an intermediate condition which can be changed into liquid or gas by slightly lowering or raising the temperature whilst the volume is kept constant. This is, in fact, the maximum density point of the gas or vapour. We thus see perfect continuity in the transition from the liquid to the gaseous state, and what we call vapour is simply gas below its critical temperature.

Every substance has its own critical temperature; that for steam being 412° C., above which it cannot be condensed. The so-called "permanent gases" have extremely low critical temperatures, and also require enormous pressure to liquefy them. Pictet reduced hydrogen and oxygen to about one hundred and forty degrees below the freezing-point of water (−140° Cent.) and subjected them to great pressure. Upon opening a stopcock to allow the contents of the tube to escape, the pressure of the liquid jet was 320 atmospheres in the case of oxygen, and 640 or 650 for hydrogen, both containing solid particles, that of hydrogen being a steel-blue colour, and producing a crackling metallic noise on the floor, as if extremely small shot was falling on it. The presence of these small solid particles in both jets was demonstrated by their action on polarised light.

Thus, just as water is vapour liquefied or steam condensed, and ice is water solidified, man has discovered that every other substance is capable of existing in these three states—solid, liquid, and gaseous.

GEOLOGY.—XII.

[*Continued from p. 91.*]

THE EOCENE SYSTEM.

FROM the Mediterranean basin to what are now Pyrenees, Alps, Carpathians, and Caucasus, through Syria, northern India, China and Japan, open-sea conditions continued after the close of the Cretaceous epoch and a massive limestone crowded with the characteristic foraminifer *Nummulites* was laid down. In northern Europe the bed of the Chalk sea was raised so as to form several more or less distinct areas of deposit, and the outpourings of the great basalts of Auvergne, the Eifel, Antrim, Mull, Skye, and Iceland probably commenced. In Britain, Eocene rocks are confined to the two centroclinal basins in the Chalk (produced by later folding and separated by denudation) known as the London and Hampshire basins. Paris is situated on a similar basin. Both the plants and the animals they contain point to a climate almost tropical. Palms, *Voluta*, *Conus*, *Oliva*, *Nautilus*, turtles, crocodiles, and sea-snakes indicate this. Besides sharks and a few birds, Eocene beds have yielded a variety of mammalian remains, especially interesting from their generalised character, combining, as they do, features of various groups now distinct. Such are the *Tillodontia* and *Eohippus*, the small ancestor of the horse, from the western United States, the tapir-like *Palæotherium* of Europe, the carnivora with marsupial affinities, and the lemuroid *Cænopithecus*. The British Eocenes may be divided as follows:—

	Hampshire.	*London Basin.*
UPPER	Barton Clay	Upper Bagshot Sands.
MIDDLE	Bracklesham, Bournemouth, and Alum Bay beds	Middle Bagshot Sands. Lower Bagshot Sands.

	Hampshire.	*London.*
Lower	Bognor Clay Woolwich and Reading Clay	London Sands. London Clay. Woolwich and Reading Clay Thanet Sands.

The marine *Thanet Sands* thin out west of London and in Suffolk. They contain *Cyprina Morrisii*, but are mainly unfossiliferous. Lines of large masses of compact sandstone known as Sarsen stone occur in them. The *Woolwich Clay*, in the east, is estuarine with *Ostrea bellovacina*, *Cyrena cuneiformis*, *Melania inquinata*, etc., often in thick shell-beds, turtles, crocodiles, and wading birds, with lignite, flint shingle, and, in Hertfordshire, conglomerate. The *Reading Clay* seems rather fresh-water. It is various in colour. Extensive flint shingles constitute the so-called *Oldhaven Beds* of Sheppey at the top of the group. The marine *London Clay*, extending to Hungerford, Berks. and into Suffolk, 500 feet thick, seems to have been deposited in a tropical bay in water about 100 fathoms deep. At Sheppey it has yielded the fruits of *Nipadites* and other palms; crabs, such as *Xanthopsis*; many gastropods, especially *Pleurotoma* and *Fusus*; *Nautilus*; rays, sharks, turtles, crocodiles; *Palæophis*, a sea-snake; birds; an opossum and other mammals. At Hampstead it is capped by the *London Sands*, connected with those of Bagshot Heath and a wide area in west Surrey and in the New Forest. The *Bagshot Sands* in the London Basin, seldom more than 200 feet thick, are mainly yellow and unfossiliferous, with masses of Sarsen stone in the Upper part. These masses strew the chalk downs of Berks, Hants, and Wilts, where the sands have been denuded. The outer circle of Stonehenge is composed of them. In the Hampshire Basin the Lower Bagshot Sands are 660 feet thick and variously coloured, with beds of lignite and plant-bearing pipe-clays, as at Alum Bay and Studland. The Middle Bagshot beds here are over 100 feet thick, sands and clays partly fresh-water, occurring at Alum Bay, highly inclined by the axial monoclinal of the Isles of Wight and Purbeck, but spreading out along the coast from Bournemouth eastward to Highcliff and at Bracklesham in Sussex. (See Coloured Plate, Vol I., p. 321, which gives Mr. J. S. Gardner's classification.) Among their many fossils *Sabal*, a palm, tapiroid mammals, turtles, crocodiles, numerous species of *Voluta*, *Cardita planicosta*, etc., show a sub-tropical climate, and *Nummulites*, which builds up the great limestones of this age in the south, also occurs. The Upper Eocene or *Barton Clay* is in this area 300 feet thick, grey, and full of well-preserved fossils, including *Voluta luctatrix*, *V. ambigua* and *V. athleta*, *Conus*, *Crassatella sulcata*, *Chama squamosa*, and *Nummulites*. The lignite, largely made up of *Sequoia Couttsiæ*, associated with pipe-clay in an old lake-basin at Bovey Tracey, east of Dartmoor, and some at least of those between the great basalt-sheets, 900 feet thick in Antrim, 3,000 feet thick in Mull, and extending into Greenland, are assigned to this period by Mr. Gardner.

THE OLIGOCENE SYSTEM.

After Eocene times a continental period, with extensive lakes in which fresh-water and marine deposits were laid down conformably to the Eocene, seems to have prevailed over most of Europe. In Switzerland 6,000 feet of lacustrine sandstones, marls, and conglomerates ("nagelfluh"), known as "molasse" and now elevated into the Rigi and Rossberg, were deposited, as were also the lignites or "brown coals" of the Lower Rhine and the glauconitic sands containing amber at Königsberg. The eruptions of Antrim, Mull, Skye, the Faröes, and Greenland probably continued, those in Auvergne and the Eifel being somewhat later, and this and the Miocene epoch were probably the period when the Alps and Pyrenees were uplifted and the great east and west folds of Cretaceous and Eocene rocks were produced that formed the Vienna, Paris, Artois, Hampshire, and London basins, the monoclinal of Dorset and Wight and the anticlinal of the Weald. Whilst no living species of mollusca can be with certainty identified in the Eocene, the Oligocene contains a few. In Britain it is perhaps solely represented by the beds formerly known as the "Fluvio-marine series" of the north of the Isle of Wight and the neighbouring coast, which were once termed Upper Eocene. They are thin-bedded marine, brackish, and fresh-water sands, clays, marls, and limestones, and are thus divided:—

HEMPSTEAD BEDS.—Marls, about 160 feet thick, mostly fresh-water and estuarine, with *Paludina lenta*, *Melania*, *Cyrena*, *Unio*, cyprids, and gyrogonites. A marine clay with *Corbula* above.

BEMBRIDGE BEDS.—Estuarine marl (62 feet), with *Ostrea vectensis*, and fresh-water limestone (20 feet), with *Limnæa longiscata* below.

OSBORNE, ST. HELEN'S, OR BROCKENHURST BEDS.—About 70 feet thick, fresh-water, with the Nettlestone Grit, a building stone.

HEADON BEDS.—Clays and limestones, 180 feet thick, fresh water above and below, marine in the middle.

Palæotherium and other tapiroid forms occur, especially in the gypsum beds of Montmartre near Paris, but give place to the *Rhinoceros* at the close of this epoch. Carnivora occur, but still with marsupial characters.

THE MIOCENE SYSTEM.

Britain being dry land was losing by denudation, not receiving deposits, during this epoch; but large

lakes and shallow arms of the sea covered much of Europe. From these, especially the lacustrine Œningen beds of Switzerland, abundant plant and animal remains have been obtained. Tropical palms, figs, acacias, and myrtles seem gradually to give place to the more temperate poplar, hornbeam, and birch types. The small three-toed horse, *Anchitherium*; deer; *Rhinoceros*: the earliest bear, *Hyænarctos*; the sabre-toothed lion, *Machairodus*; and true apes occur; but the most prominent forms are the proboscideans, *Deinotherium*, with tusks curving downward from the lower jaw; and *Mastodon*, differing from the elephant mainly in its teeth.

THE PLIOCENE SYSTEM.

This system, representing the epoch when the existing continents were taking their present form, in Europe only attains any considerable thickness in the basin of the Mediterranean, where several thousand feet of marine beds had accumulated before the first outburst of Etna and Vesuvius. In England it is mainly represented in Norfolk, Suffolk, and Essex, where the beds, locally known as Crag, rest unconformably on Chalk or London Clay; and at St. Erth, in Cornwall. They consist of marl, shelly sands, and clays, mostly marine, containing 80 to 90 per cent. of still living species of mollusks, the name Pliocene meaning that this percentage exceeds fifty, and are thus subdivided:—

Westleton and Mundesly Crag and Cromer Forest-bed, 10 to 70 feet.
Chillesford beds, 6 to 16 feet.
Norwich, or Fluvio-marine Crag, 5 to 10 feet.
Red Crag, 25 feet.
White, Suffolk, "Coralline," or Bryozoan Crag, 40 to 60 feet.

At the base of the system are beds of phosphatic nodules and fossils, derived from the Miocene or from the Antwerp Black Crag. These so-called Coprolite Beds, which are largely worked for manure, contain bones and teeth of *Mastodon*, *Elephas meridionalis*, *Rhinoceros*, *Hipparion*, *Equus*, *Cervus*, *Hyæna*, *Felis*, walrus, whales, and sharks. The *White Crag* consists of sands and marls misnamed Coralline from the abundance of its Polyzoa, 140 species, especially *Fascicularia*. *Terebratula grandis*, *Voluta lamberti*, and *Astarte omalii* are characteristic, the latter being one of the northern forms which constitute 5 per cent. of its mollusca. The *Red Crag* is a ferruginous sand, full of shells, ten per cent. of which are northern. *Voluta lamberti*, *Trophon antiquum*, *Purpura tetragona*, *P. lapillus*, *Pectunculus glycimeris*, the mussel, cockle, and scallop are abundant. The *Norwich Crag* is a shelly sand, containing some land and fresh-water shells, together with cockles, *Astarte borealis* and others, 14 per cent. being northern, *Mastodon*, *Elephas meridionalis*, *E. antiquus*, *Rhinoceros*, *Hippopotamus*, horse, deer, and *Trogontherium*, a large beaver. The *Chillesford beds* are sands and clays with *Astarte borealis*, *Tellina obliqua*, *Cyprina islandica*, *Mya*, etc., 66 per cent. being northern. The Cromer *Forest-bed* is estuarine and marine, with peat and drifted fir-stumps, many plants, mostly of existing British species, land and fresh-water shells, and 50 species of mammals including *Machairodus*, *Canis*, marten, glutton, grizzly bear, seal, horse, rhinoceros, hippopotamus, pig, ox, roe-deer, red-deer, *Cervus megaceros*, *Trogontherium*, beaver, mole, *Elephas meridionalis*, *E. antiquus*, and *E. primigenius* (the Mammoth). This bed is only exposed at low tide beneath cliffs of boulder clay. Certain gravels at Westleton and Mundesley and elsewhere are pre-glacial, and may be of about this age. Interesting assemblages of Pliocene animals have been described from Pikermi in Attica and the Sivalik Hills in India.

THE PLEISTOCENE SYSTEM.

Resting indifferently and unconformably on rocks of all earlier periods are a varied series of rocks, all the mollusca in which belong to living species. From their position these deposits are termed *Superficial*, and as they mostly contain evidence of the presence of man, some geologists have made them into a separate or Quaternary Group. It is, however, difficult to separate them from the Crag, or in many cases to decide on their relative antiquity or sequence. Two series are commonly distinguished: the lower, or *Glacial*, containing many extinct mammals and others now living only in distant regions; the upper, or *Recent*, containing few, if any, extinct mammals. The gradual refrigeration of the climate, the evidence of which we have traced from Miocene times, continued until much of Europe and North America seem to have been under an ice-sheet. There is abundant evidence of intense ice-action, roches moutonnées, boulder clays, which are either ground-moraines or deposits in ice-laden seas, eskers and other moraines, erratics and "parallel roads" with northern shells and mammals, in these deposits and in our older river-gravels and cave-deposits. The woolly mammoth (*Elephas primigenius*) and rhinoceros, the reindeer (*Cervus tarandus*) and the musk-ox (*Ovibos moschatus*), of which the two former are extinct, were mammals adapted to great cold; yet they occur in southern Europe. Hippopotamus, hyæna, lynx, and lion are believed to point to warmer "Inter-glacial" episodes; and to such times, at the earliest, belong the earliest evidence of man yet found in any part

of the globe. His rude weapons of chipped flint have been found, as at Stoke Newington, under gravel-beds showing marked signs of ice-action. We cannot here discuss the astronomical reasons which have been given for the Glacial Period, the wide-spread, thick, and often unstratified deposits of which were once known as Diluvial. To such a comparatively recent period belong the gigantic sloths and armadillo (*Megatherium*, *Glyptodon*, etc.) of South America, and the great Kangaroos (*Diprotodon*) of Australian caves. The discussion of the early history of man and his tools, weapons, and arts belongs to the anthropologist and archæologist; but we may just mention here that among the chief recent deposits in which his remains are found are river-gravels and brick-earths, peat-mosses, lake-mud in which pile-dwellings occur, cave-deposits, raised sea and river beaches and the shell-mounds or kitchen-middens of his own construction. In gravels, brick-earth, peat and cave-deposits alike, his implements and bones have been repeatedly found in association with those of *Machairodus*, mammoth, and *Cervus megaceros* (the great Irish deer) among animals now extinct, as well as with others no longer inhabiting the same regions; so that his prehistoric antiquity must be very great. The human or recent period has been subdivided into four by the nature of man's weapons, the *Palæolithic* or older Stone age, represented in the high-level river-gravels, perhaps glacial, when chipped stones were used; the *Neolithic*, when polished stones were used, apparently an age of great advance, represented by low-level gravels; the Bronze and the Iron ages.

COMMERCIAL BOTANY OF THE NINETEENTH CENTURY.—IX.

[*Continued from p. 104.*]

OILS AND WAXES.

The extended use of gas and the discovery of the petroleum or mineral oils during the last few years have had a marked effect upon diminishing the use of vegetable oils as illuminants. The spread of machinery, on the other hand, has had an opposite effect in creating a demand for oil for lubricating purposes, besides this there is always a large demand for drying oils for mixing paints and for similar uses. These facts, together with the increased use of oil-cake for feeding cattle, cause a pretty brisk sale of oil seeds generally, and oil-crushers are alert and always ready to give a trial to any new product of this nature arriving in the English markets. A large quantity of these oil seeds, especially those from the West Coast of Africa and Brazil, find their way to the port of Liverpool, and it is surprising how often new products of this nature, together with old ones that have, perhaps, been sent years before and forgotten, do come into that port. With a seed new to a broker, coming into his hands for the first time, it is necessary that he should make himself acquainted with its nature or properties—whether the oil it contains is wholesome or poisonous—before he effects a purchase, it may be of a whole ship-load. The nature of the seed governs not only the oil itself, but also the marc or cake left after expression which, in the case of a sweet oil, would be valuable for cattle-feeding, while, on the other hand, in the case of a poisonous oil might bring about serious consequences.

The best-known oils, and those which are most largely employed, especially in soap and candle-making—which take the bulk of the oils imported—are Cocoa-Nut and Palm Oil. The first, it is well known, is the produce of *Cocos nucifera*, a widely spread tropical palm, and the second the produce of *Elæis guineensis*, a palm confined to West Africa. The trade in both these oils has been largely developed since 1840, and is due to a great extent to the energies of Price's Patent Candle Company, which had its beginnings some sixty years or more since. For some time the oil alone was imported, the cocoa-nut kernel being crushed in Ceylon, whence the bulk came. Of late years, however, both oil and dried kernel have been imported, the latter known as "copra," which is submitted to pressure in this country. So rapid did the utilisation of cocoa-nut oil become after the establishment of the company just referred to, that they turned out in the month of October, 1840, twenty tons of cocoa-nut candles of the value of £1,590, and about twelve tons of stearic and composite candles valued at £1,227. In October, 1855, the quantity of stearic and composite candles made by the firm amounted to 707 tons of the value of £79,500. For the purpose of the general illumination on the occasion of Her Majesty's marriage in 1840, Price's Candle Company introduced a cheap candle that should require no snuffing, composed of a mixture of stearic acid and cocoa-nut stearine. "The public, contrary to the general opinion of the candle-dealers, proved wise enough not to mind the candles being greasy, but as the light was good, the candles comparatively cheap, and the nuisance of having to snuff done away with, they received the new composite candles with great favour, and the manufacture rapidly grew."

In the development of the Palm Oil industry from *Elæis guineensis* a very important substance.

namely GLYCERINE, was discovered; it was first used in one of the hospitals for skin diseases in 1844. Its uses at the present time are very numerous, and are well known. About the year 1848 night-lights were introduced, and in the following year the well known "Child's Night-Lights" began to be made in large quantities.

The following are the returns of cocoa-nut and palm oil for the years stated:—

COCOA-NUT OIL.

1847	48,320 cwt.
1857	207,239 ,,
1867	124,314 ,,
1877	194,052 ,,
1887	183.766 ,,
1897	242,731 ,,

PALM OIL.

1847	366,840 cwt.
1857	854,791 ,,
1867	812,080 ,,
1877	885,138 ,,
1887	966,536 ,,
1897	973,108 ,,

GROUND NUT (*Arachis hypogæa*).—This is a diffuse herbaceous annual, growing one or two feet high; unknown in a wild state, but now much cultivated for the sake of its oily seeds in all tropical and sub-tropical countries, especially in West tropical Africa. After the fall of the flower the young pod pushes its way beneath the surface of the earth, where it ripens. The introduction of the ground-nut as an oil seed into European trade dates from 1840, since which time the imports have increased enormously. There are no authentic records of the imports of Ground-nut oil, but West Africa, India, and China supply by far the largest bulk. The oil is very free from stearine, and is consequently much used in pharmacy in the same way as olive oil, especially in India. With us it is also largely used for culinary and industrial purposes, as soap-making, etc.

COTTON SEED.—The cotton seed of commerce is furnished by several species of *Gossypium*. The seeds were first imported into the English market as oil seeds some forty or forty-five years ago, but it is quite within recent years that the trade has assumed a position of importance. In America at the present time it has taken the place of a distinct industry, over 400,000 tons of seeds being annually expressed, the quantity indeed increasing every year. A large quantity of this oil comes to this country directly and indirectly. Egypt also sends cargoes of seeds to English ports for expression here. Much of the oil is used by soap-makers, besides which it makes a good lubricating oil, and when carefully refined in France and put into white glass bottles, it is sent into this country as "Pure Olive Oil" and used for culinary purposes. In a paper of December, 1888, the British Consul at Venice, reporting on the trade and commerce of that port for 1887, says that the action of the Italian Government in enacting a higher import duty on Cotton oil with the intention of preventing its being mixed with Olive oil has had a contrary effect, the price of Olive oil being considerably lowered, the reason of which is said to be that by the mixture of Cotton oil with the ordinary qualities of Olive oil produced in the South of Italy, these qualities find an easier and more profitable sale. The residual cake, after the expression of the oil, is used for feeding cattle and as a fertiliser for the land.

DIKA or UDIKA FAT.—This, under the name of DIKA BREAD, was first exhibited at the Paris Exhibition in 1855 as the produce of *Mangifera gabonensis*. In 1859 it was brought to the notice of the Pharmaceutical Society, and in 1862 a report of its nutritive value was published in the *Journal* of the same Society; from this it would seem that its composition is analogous to coffee, tea, cocoa, etc., and it was then suggested that it might become an article of commerce into this country. The substance is composed of the fatty kernels of the seeds of *Irvingia Barteri*, a Simarubeous tree of West tropical Africa, and is made into masses of a cone-like form, sometimes weighing as much as fifty pounds. It contains 70 to 80 per cent. of solid fatty matter, and forms an important article of food amongst the natives.

Telfairia occidentalis.—A climbing plant belonging to the order Cucurbitaceæ, native of West tropical Africa, where the plant is cultivated for the sake of its seeds, which contain a sweet bland oil. They are cooked and eaten by the natives, and are said to be very palatable. The seeds are occasionally brought into Liverpool as oil seeds. The plant, which flowered at Kew in 1876, was raised from seeds received in 1870 from the Liverpool Botanic Garden.

Myristica angolensis.—A native of Angola, where it is known as MUTUGO. The seeds, which are about three-quarters of an inch long and half an inch broad, are ruminated like an ordinary nutmeg, but have no aroma and but little or no taste. They are said to contain about three-fourths of their weight of fatty oil. They were first imported into Liverpool as oil seeds in 1884.

Other species of *Myristica* to which attention has been directed as oil seeds are:—1. *M. surinamensis*,

imported into Liverpool from Para as oil seeds in 1881. Like the former they have no smell and very little taste. They are nearly globular, about the size of a small marble, and are known as CUAGO nuts by the Spaniards.

2. *M. guatemalensis.*—A native of Guatemala, the seed of which is ovoid, about one inch long and half an inch broad. This also yields a solid fat in large quantity.

Hyptis spicigera.—An herbaceous plant belonging to the natural order Labiatæ. The small black seeds contain a large quantity of oil, and are occasionally imported into Liverpool from the West Coast of Africa. They made their first appearance in 1883.

Polygala rarifolia.—A shrubby plant belonging to the natural order Polygaleæ, native of West Africa, about Sierra Leone and Angola. The seeds are very oily, and were first received at Liverpool in 1884.

Lophira alata.—Under the name of MENI, these seeds have recently been brought into Liverpool from West Africa for the sake of the oil they contain. The plant belongs to the natural order Dipterocarpeæ, called in Sierra Leone LAINTLAINTAIN.

Lallemantia iberica.—A plant belonging to the natural order Labiatæ, and said to be cultivated to a considerable extent from Syria to Northern Persia. The small seeds contain a very large quantity of sweet limpid oil, suitable for culinary or other purposes. It was introduced to notice in England in 1880.

Under the names of M'pogo nuts, Mabo nuts, and Niko nuts, the hard bony fruits, minus the fleshy coverings in which they are enveloped when fresh, come occasionally into the port of Liverpool from the West Coast of Africa, chiefly from Liberia and the Gaboon. The fruits of the M'pogo, which are imported from the Gaboon, are about two inches long and from one to one and a half inches in diameter. They contain three or four small roundish seeds, from which a very large percentage of oil can be expressed. The Mabo fruits are of an oblique-ovoid form, two inches or more long, and about an inch in diameter, with a very rough or channelled surface. The seeds of this kind are also very rich in oil, of a very fluid character. These fruits and seeds are imported from Liberia. The Niko nuts, which come also from Liberia, are of a similar bony nature, about two inches long and one and a half inches in diameter. The seeds, like the other kinds, contain a large proportion of oil. Neither of these have become established articles of trade, though the oil seems to be of a character that might become useful. They have never been botanically identified, though it has been surmised that they might prove to belong to the genus *Parinarium*, of the natural order Rosaceæ; probably, however, they may prove to be a species of *Elæocarpus*. They first made their appearance in Liverpool some twenty or thirty years since.

In February, 1891, some oil seeds were received at Liverpool from the West Coast of Africa, and attracted a considerable amount of attention in consequence of the large quantity of oil the kernels appeared to contain rather than to its quality and properties, which indeed have not, so far as we are aware, up to the present time, been tested. These seeds appear to belong to the genus *Heisteria*.

In the *Kew Bulletin* for 1891, p. 218, attention is drawn to the preparation of table oils from the seeds of the Beech (*Fagus sylvatica*) and the Linden, or Lime (*Tilia europæa*), both of which are said to have been used in Southern Germany for this purpose in consequence of the difficulty and expense in obtaining pure olive oil. The Beech is said to contain 22·77 per cent. of oil and the Linden 58 per cent., and the latter to possess "a peculiarly fine flavour."

GEOGRAPHY.—XXI

[Continued from p. 120.]

SOUTH AMERICA.

Position and Coastline.—South America contains about six and a half million square miles, or more than once and a half the area of Europe. Its outline is more compactly triangular than that of North America, giving only one mile of coast to every 440 square miles of area. Its greatest length, from *Point Gallinas*, in lat. 13° N., to *Cape Horn*, nearly 57° S., is over 4,500 miles; and its greatest breadth, from *Point Pariña*, in 81° 10' W., to *Cape St. Roque*, in 35° 40' W., is 3,200 miles. As the meridian of 80° W. passes west of *Quito* and *Panama*, east of Florida and through James's Bay, the southern continent is obviously east of almost all the northern one. Its broadest part, and in all four-fifths of its area, are within the tropics; but it extends 22° farther south than Africa. On the north the *Gulf of Darien* is north-east of the *Isthmus of Panama*; *Point Gallinas* is west of the *Gulf of Venezuela*, the entrance to *Lake Maracaybo*. The small Dutch islands of *Aruba*, *Curaçoa*, *Buen Ayre*, etc., lie off the coast, as does the larger British island of *Trinidad*, off the north of the delta of the Orinoco, in the north-east. Thence the coast trends south-eastward, past the mouth of the Amazon to *Cape St. Roque*, and thence, with no great promontories south-westward, past that of the

La Plata, to the stormy *Straits of Magellan* (or Magalhaens), which divide the island of *Tierra del Fuego* from the mainland. The southernmost point of the mainland is *Cape Froward* in 54° S., *Hoste Island*, *Cape Horn*, and others being separated from Tierra del Fuego by the *Beagle Channel*. About 300 miles east of the Straits of Magellan are the *Falkland Islands* (see Vol. II., p. 242). The west coast trends due northwards to lat. 17° S., having the *Chonos Archipelago*, *Chiloé*, and other islands off the coast of Patagonia, and *Juan Fernandez* (Alexander Selkirk's island) about eight degrees west of Valparaiso. From Arica (17° S.) the coast trends north-westward to the *Gulf of Guayaquil*, south of the equator; and from that, north-eastward to the *Gulf* or *Bay of Panama*, south of the isthmus. Throughout its course this west coast is closely parallel with the great mountain-axis of the continent. On the equator some ten degrees to the westward are the *Galápagos Islands*.

Surface and Drainage.—Physically, there are five regions in South America—the west coast; the basin of the Orinoco; the basin of the Amazon; the Southern Plain; and the Plateau of Eastern Brazil. The *West Coast region*, 50 to 150 miles wide and 4,000 miles long, skirting the Pacific, is fertile in the north and south, where the prevalent winds strike the Andes from the west, but is a rainless sandy desert in the middle, where the winds from the east have to traverse the widest part of the continent, and are finally exsiccated by the mountains. The *Andes* (Cordilleras de los Andes), the longest mountain-chain in the world, follow approximately the meridian of 72° W. Their average height is 11,000 or 12,000 feet, or about 3½ miles. The southern part of the chain, or *Andes of Chili*, is a single line of mountains with *Corcovado*, the southernmost, and *Aconcagua*, in 32° S. (23,900 feet) the loftiest, volcano in a mountain-system the whole range of which is largely volcanic. About lat. 25° S. the chain widens out into the *Plateau* or *Andes of Bolivia*, reaching 400 miles in width and from 11,000 to 16,000 feet in altitude, and enclosing the only region of inland drainage in South America, the freshwater *Lake Titicaca*, nearly 4,000 square miles in area and at an altitude of 12,847 feet, draining, by the *River Desaguadero*, into the smaller saline *Lake Aullagas*, 200 miles to the south-east. East of this lake is the peak of *Sorata* (24,812 feet); and northward the plateau extends in several parallel chains, the *Andes of Peru*, converging towards the equator into the *Plateau of Quito* (9,600 feet) with its cluster of volcanic peaks, *Chimborazo* (21,424 feet), *Cotopaxi* (18,875 feet), and *Antisana* (19,137 feet), of which the two latter are active. To the north the system again divides into three, the *Western*, *Central*, and *Eastern Cordillera of Colombia*, enclosing elevated valleys, which slope gradually northward, and are drained by the rivers *Cauca* and *Magdalena*, which unite and enter the Caribbean Sea. The Magdalena drains a basin 700 miles long with an area of 72,000 square miles. From the Eastern Cordillera about lat. 9° N. the *Cordillera of the coast*, a transverse chain known also as the *Sierra Nevada de Santa Marta* and in part as the *Sierra de Merida*, from 15,000 to 4,000 feet in height, extends north-eastward and eastward through Caracas to the Gulf of Paria between Trinidad and the Orinoco delta. This is the only range in South America besides the Andes that reaches the snowline. It forms the northern watershed of the *basin of the Orinoco*. This basin consists largely of steppes, called "llanos," with few trees but with tall herbage which is parched up during the intensely hot dry season and flooded during the rainy summer. The *Orinoco*, 1,800 miles long, drains a basin 1,000 miles long, and containing 400,000 square miles of area and 8,000 miles of navigable waters. One of its tributaries, the *Cassiquiari*, joins the *Rio Negro*, a tributary of the Amazon. Between lat. 4° and 2° N. a great forest-clad table-land, including the *Sierra Parima*, *Roraima*, and the other mountains of Guiana, divides the basins of the Orinoco and the rivers of Guiana, the *Essequibo*, *Corentyn*, *Surinam*, etc., from the Rio Negro, its tributary the *Parima*, and the other northern tributaries of the Amazon. The *basin of the Amazon* is a vast plain of more than two million square miles, or half the area of Europe, with rich soil and a moist climate, almost covered by dense forests ("selvas"). The *Amazon*, the largest river in the world, rises, as does its first important tributary, the *Ucayali*, in the Peruvian Andes and flows mainly eastward, from 10° S. to the equator, for 4,000 miles, through a basin 2,100 miles in direct length, receiving in succession the *Ucayali* and *Purus* from the south, the *Negro*, as large as itself, from the north, and the *Madeira*, *Tapajos*, and *Tocantins* from the south, and entering the Atlantic by two mouths. It is navigable to the foot of the Andes, not having a single rapid below 78° W. long. where it is only 1,240 feet above sea-level. The current travels thence to the sea in forty-five days, while an eastern breeze (trade-wind) blows perennially against the stream. The river and its tributaries afford, perhaps, 50,000 miles of navigation, and its discharge is more than that of the eight chief rivers of Asia combined.* There

* The Yenesei, Indus, Ganges, Obi, Lena, Amoor, Hoang-ho and Yang-tse.

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SOUTH AMERICA.

Position and Coastline.—South America contains about six and a half million square miles, or more than once and a half the area of Europe. Its outline is more compactly triangular than that of North America, giving only one mile of coast to every 440 square miles of area. Its greatest length, from *Point Gallinas*, in lat. 13° N., to *Cape Horn*, nearly 57° S., is over 4,500 miles; and its greatest breadth, from *Point Pariña*, in 81° 10′ W., to *Cape St. Roque*, in 35° 40′ W., is 3,200 miles. As the meridian of 80° W. passes west of *Quito* and *Panama*, east of Florida and through James's Bay, the southern continent is obviously east of almost all the northern one. Its broadest part, and in all four-fifths of its area, are within the tropics; but it extends 22° farther south than Africa. On the north the *Gulf of Darien* is north-east of the *Isthmus of Panama*; *Point Gallinas* is west of the *Gulf of Venezuela*, the entrance to *Lake Maracaybo*. The small Dutch islands of *Aruba*, *Curaçoa*, *Buen Ayre*, etc., lie off the coast, as does the larger British island of *Trinidad*, off the north of the delta of the Orinoco, in the north-east. Thence the coast trends south-eastward, past the mouth of the Amazon to *Cape St. Roque*, and thence, with no great promontories south-westward, past that of the

to Chili are of great value. Diamonds are obtained in Brazil. Botanically, South America falls into six regions: (i) the region of cacti and peppers, including the northern part up to altitudes of 5,000 feet, producing the vegetable-ivory and other palms, the *Victoria regia* water-lily, and among cultivated plants, chocolate, vanilla, yams, plantains, sugar, and coffee; (ii.) the region of cinchonas, the Andes, up to 9,600 feet, between 5° N. and 20° S., in which the potato occurs; (iii.) the region of calceolarias, in the same latitudes, but at greater altitudes; (iv.) the region of palms, including the basin of the Amazon, with luxuriant forests of enormous myrtaceous and other trees covered with lianas and innumerable epiphytes, ferns, aroids, orchids, and others; (v.) the region of arborescent *Compositæ*, from the Tropic of Capricorn to 40° S., with araucarias and calceolarias, where wheat, peaches, and the vine are cultivated; and (vi.) the Antarctic region, with the fuchsia, crow-berry, and two species of beech. The most valuable timber-trees of South America are the greenheart and mora of Guiana; and caoutchouc, cinchona, and Paraguay tea are also important vegetable products. The animals of South America are very distinct from those of other regions. Insect-life is wonderfully varied, chigoes, mosquitoes, locusts, termites, and brilliant butterflies abounding, besides tarantulas, scorpions, and centipedes. The species of fish are often confined to one portion only of a river, over 2,000 occurring in the Amazon basin. Among the chief reptiles are the crocodile, alligators, boa, and rattle-snake; and the birds are exceptionally numerous, numbering more than 2,300 species, or thrice the variety of North America, including the condor of the Andes, the rhea or American ostrich of the pampas, humming-birds, parrots, and toucans. Opossums, sloths, ant-eaters, and armadillos; dolphins, porpoises, and manatees in the larger rivers; the rodent viscacha in the southern pampas, and the capybara further north; tapirs, and peccaries; the llama, guanaco, alpaca, and vicuña, the second of which is the most widely diffused, though the hair of the alpaca of Peru is the most valuable; vampire bats; the jaguar and puma, the latter ranging fifty degrees on either side of the equator; and numerous monkeys, characterised by their wide (platyrhine) nasal septum and prehensile tails destitute of hair beneath, are among the chief mammals. Remarkable allied forms of sloth, armadillo, and llama of gigantic size have been found fossil in comparatively modern (Pleistocene) deposits. Cattle and horses, though of European introduction, form vast semi-domesticated herds on the pampas, so that meat, fresh and preserved, meat extract, tallow, hides, wool, and horsehair form the chief exports from Uruguay and the Argentine Republic. Of the population, estimated at over $34\frac{1}{2}$ millions, two-fifths are native Indians, one-fifth whites, and one-tenth negroes, chiefly in Brazil. The rest are of mixed race. The whites in Brazil are of Portuguese origin; elsewhere, except in Guiana, mainly Spanish.

Political Divisions.—South America is divided between thirteen powers, which, with their areas, ratios to Great Britain, and populations, are given in the following table, from the north southward:—

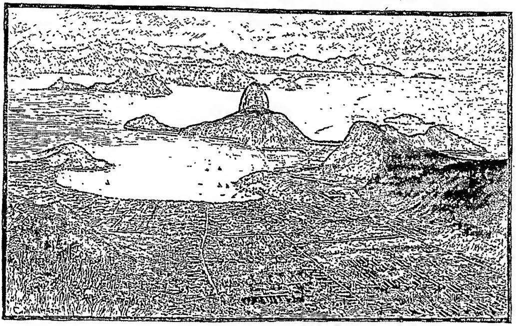
	Area in sq. miles.	Ratio to G. Britain.	Population.
Colombia	502,000	$3\frac{3}{4}$	5,000,000
Venezuela	566,000	$6\frac{5}{8}$	2,300,000
Guiana, British	109,000	1	285,000
Guiana, Dutch	46,000	$\frac{1}{2}$	65,000
Guiana, French	46,880	$\frac{1}{2}$	26,000
Brazil	3,260,000	36	17,000,000
Ecuador	120,000	$2\frac{3}{4}$	1,200,000
Peru	455,000	$4\frac{1}{2}$	2,900,000
Bolivia	570,000	$5\frac{1}{4}$	2,000,000
Chili	290,000	$2\frac{7}{8}$	3,300,000
Paraguay	145,000	$1\frac{5}{8}$	600,000
Uruguay	72,100	$\frac{7}{8}$	780,000
Argentine Republic	1,200,000	$12\frac{3}{8}$	4,000,000

The ten independent States in the above list are all republics; Brazil, till 1822 Portuguese, and till the year 1889 an empire; the rest until 1812 to 1823 Spanish. The prevailing religion throughout the Continent is Catholic, other forms being tolerated.

COLOMBIA, formerly New Granada, between 12° 25′ N. and 2° 40′ S. lat., and between 83° and 68° W. long., is rich in forests, precious stones, and gold. It also exports cinchona-bark, coffee, tobacco, hides, caoutchouc, and dye-woods. There are over 340 miles of railway open; and the *River Magdalena* is navigable for nearly 600 miles. The *Isthmus of Panama*, traversed by a railway, from Colon, or Aspinwall, on the Caribbean Sea, to Panama, on the Pacific side ($47\frac{1}{2}$ miles) with a summit-level of 260 ft., and across which a ship-canal has been commenced, is within this republic. Bogota (100), 6,200 miles, or 35 days from London, at an altitude of 8,600 feet, is healthy. *Aspinwall* or *Colon*, on the north side of the isthmus, is the chief port, connected by steamers with St. Thomas in the Virgin Islands (1,300 miles), and with Southampton (4,900 miles). *Panama*, on the Gulf of Panama, is fortified, and is similarly connected with San Francisco. *Cartagena*, on the Caribbean Sea, is also a port.

VENEZUELA, between 12° 12′ and 1° 30′ N. lat.,

is a formidable bore at its mouth. The *Southern Plain* includes the basin of the Plata, the dry "pampas" southward to the *Rio Negro*, and the terraced gravel-plains of Patagonia. In the mountains of Southern Brazil (*Minas Geraes*) the *River Paranahyba* has its head-waters near those of the Tocantins; and further west, near Matto Grosso, the *Paraguay* rises within a few miles of the Madeira, both of these streams being navigable almost to their sources. The Paranahiba and Paraguay flow southward on the east and west of the republic of Paraguay, respectively, the former turning westward and entering the latter at *Corrientes*. The united stream, known as the *Paraná*, continues southward, the *River Uruguay* (800 miles) flowing parallel to it to the west of the province of Entre Rios until the Paraná turns eastward and widens into the broad shallow estuary to which alone the name *Rio de la Plata* properly belongs. This system drains over a million square miles, the main stream being 2,400, and the total length of navigable waters 20,000 miles. On the plateau of eastern Brazil are several mountain-chains, roughly parallel with the east coast and seldom exceeding 5,000 feet: the *Cordillera Grande* divides the Tocantins from its western tributary the *Araguay*, and is almost continuous with the *Sierra de Santa Marta* between the Paraguay and its tributary the Paranahiba; other chains separate the Tocantins from the northern *Paranahiba* (700 miles) and the basin of the latter from that of the *San Francisco* (900 miles); and another skirts the coast at a distance of from 50 to 250 miles from Uruguay to Bahia.



Rio de Janeiro. (*From a Photograph by Spooner & Co.*)

Climate, Productions, and Population. — The Andes, the trade-winds, and, in the south, the north-west anti-trade wind, are the key to the climate of South America. North of the equator copious rain is general. South of the equator the winds from the Atlantic are exsiccated by the mountains of eastern Brazil, the central uplands and the eastern declivity of the Peruvian and Bolivian plateau, so that this latter region and the *desert of Atacama*, to the west of the Chilian Andes, are rainless. The "campos" of southern Brazil and the *Gran Chaco*, west of the Paraguay, have only a scanty rainfall; and south of 30° S. lat., while there is plenteous rain on the west of the Andes, the treeless "pampas" of the Argentine Republic and Patagonia on the east get drier and colder as one goes southward. There is, however, a growth of tall grass and weeds that feeds herds of horses and cattle. Except the Moluccas no country is so liable to earthquakes as the west of South America. The Andes are rich in the precious metals: gold in Colombia, silver in Peru and Bolivia, and copper in Chili. The deposits of nitrate of soda in the deserts of Atacama and Tarapaca and of guano on the Lobos and other islands belonging

bounded on the west by the Paraguay and on the east and south by the Paranahiba, and has no sea-board. There are many valuable species of trees yielding rubber, bark, dyes, and timber, one of the chief being a holly yielding Paraguay tea; or "yerba de maté," a principal article of trade with the rest of South America. Oranges, sugar, rum, cotton, and tobacco are produced for export; maize, rice, and cassava, as food. **Asuncion** (35), is on the Paraguay.

URUGUAY ("La Republica del Banda Oriental del Uruguay," the republic of the east side of the river Uruguay) lies between 30° and 35° S. lat., and between 57° 42′ and 53° 25′ W. long, having the broad shallow estuary of La Plata to the south. The country is well watered and largely devoted to cattle-farming, the large farms being enclosed by wire fences. Tinned meat, wool, hides, horn, horse-hair, and tallow are the chief exports. **Monte Video** (216), the most accessible port on the La Plata, is 7,030 miles, or 25 days, from London, and is nearly on the same latitude as Cape Town and Sydney. *Fray Bentos* and *Paysandu*, on the Uruguay, are centres of the meat-extract and tinning trades.

THE ARGENTINE REPUBLIC is a federation of numerous provinces occupying a vast plain or "pampas," dry and barren in the north ("El Gran Chaco") and west, near the Andes, but with luxuriant herbage in the east. It feeds enormous herds of sheep and cattle in *Entre Rios*, between the Uruguay and Parana, *Cordoba*, and *Buenos Ayres*. In *Santa Fé*, between Entre Rios and Cordova, wheat and maize are grown for export. Wool, hides, live animals, and frozen sheep are the chief exports. *Patagonia*, south of the Rio Negro, is a less fertile gravelly desert, occupied by virtually independent Indians and herds of guanaco and rhea. Half of Tierra del Fuego, a cold wet island, inhabited by degraded savages, also belongs to the Argentine Republic. There are 9,000 miles of railway in the republic, and more are in the course of construction. **Buenos Ayres** (656), the largest city in South America, on the south side of La Plata, though not readily accessible by water, grows rapidly by a great immigration from Europe. It is 7,160 miles, or 27 days, from London.

OCEANIA.

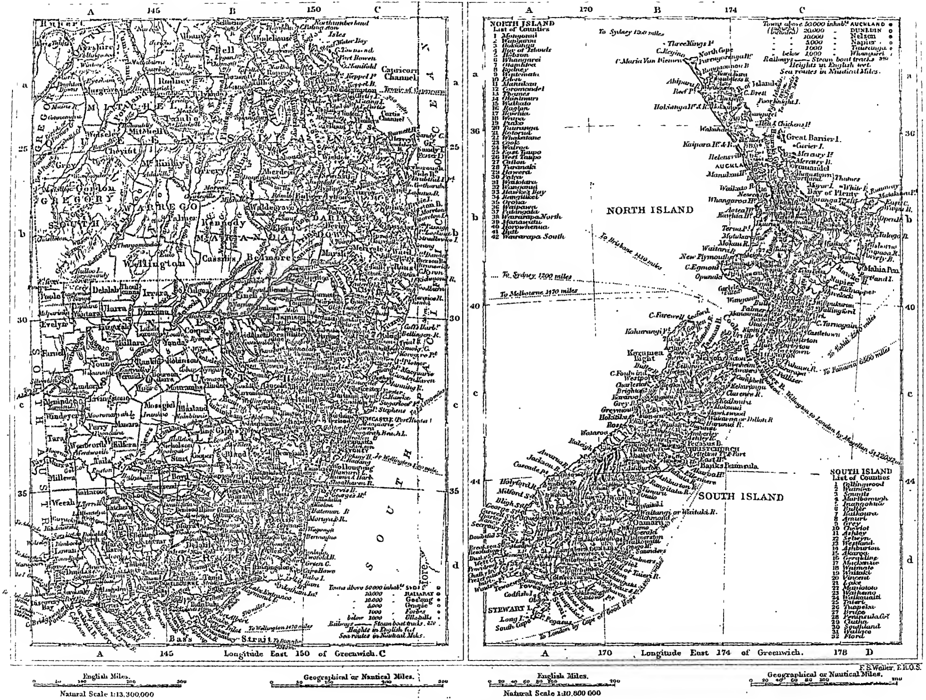
The island continent of Australia, the East Indian Archipelago, lying between it and Asia, and the numerous islands of the Pacific, are known collectively as Oceania. Its land area is about four and a half million square miles, and is divided into four regions: Australasia, Melanesia, Malaysia, and Polynesia. AUSTRALASIA, or southern Asia (Latin *australis*, southern), includes Australia, Tasmania, and New Zealand, and a few smaller adjacent islands, almost all of which, being British, have been already described (Vol. II., pp. 242–3, 313–316).

MELANESIA (Greek, μέλας, *mĕlas*, black; νῆσος, *nēsos*, an island), so called from being inhabited by the black Papuan race, a tall, bearded, pagan people with frizzled hair, includes *New Guinea* or Papua (Vol. II., p. 316), and a chain of smaller islands to the east and south-east. These are the *Bismarck Archipelago*, formerly New Britain, New Ireland, and New Hanover, now part of the German colony Kaiser Wilhelm's Land (Vol. III., p. 64); the *Solomon Islands;* the *New Hebrides*, under a joint British and French protectorate; and the French *New Caledonia* (Vol. II., p. 371).

MALAYSIA, peopled by the Malays, a short, brown or sallow, beardless, black-haired race, expert as sailors, and having thus peopled Polynesia, New Zealand, and even Madagascar, includes the large islands of *Sumatra*, *Java*, *Borneo*, and *Celebes*, and the *Moluccas* or Spice Islands, *Timor*, and the *Philippines*, all of which are largely volcanic. The natives are Mohammedans, the islands belonging mainly to Holland (Vol. III., p. 62), and producing rice, sugar, coffee, spices, and trepang. The north of Sumatra is the independent state of *Acheen;* the east of Timor is Portuguese; part of the north of Borneo is British (Vol. II., p. 124), and the Philippines are Spanish (Vol. III., p. 250).

POLYNESIA (Greek, πολύς, *polus*, many; νῆσος, *nēsos*, an island), consists of the numerous groups of small islands mostly within the tropics. North of the equator are the *Ladrone*, *Caroline*, and *Sandwich Islands:* south of it, the *Fiji*, *Tonga* or *Friendly*, *Samoa*, *Marquesas*, *Gambier*, *Austral*, and *Society Islands*. With the exceptions of the volcanic Sandwich and Fiji groups, they are mostly coral islands, their chief products are cocoa-nuts, bananas, bread-fruit, and yams, and their natives are Malays, many of whom are converts to Christianity. The Ladrone and Caroline Islands are Spanish; the Fijis are British (Vol. II., p. 316); the Marquesas, Gambier, Austral, and Society Islands are French; the Tonga and Samoa groups are independent native kingdoms. The SANDWICH or HAWAIIAN ISLANDS, since 1898 belonging to the United States, lie between 19° and 23° N. lat., and between 154° and 160° W. long., and have an area of 6,500 square miles, with 107,000 inhabitants. Hawaii, the largest, contains several volcanoes, *Mauna Loa* and *Mauna Kea* being each nearly 14,000 feet, and the crater of *Kilauéa*, being the largest active crater in the world. **Honolulu** [28], 23 days from London, has railways, steam tramways, and steam-

EASTERN AUSTRALIA



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...NGA, or FRIENDLY ISLANDS, between 15° ...S. lat., and 173° and 177° W. long., have an ...85 square miles, and a population of 17,000. ...bu exports copra, or dried cocoa-nut, as ... the SAMOAN, or NAVIGATORS' ISLANDS, ...have an area of 1,076 square miles and a ...tion of 35,000. Apia is the centre of German ...in the Pacific.

ALGEBRA.—III.

[*Continued from p. 87.*]

MULTIPLICATION.

66. EXAMPLES.—(1) What will 4 oranges cost ... x pence each?

Here we say, if *one* orange costs x pence, 4 ...anges will cost 4 times as much; they will there...ore cost $4x$ pence; and this is the answer.

(2) How much can a man earn in 5 months at a pounds per month? Reasoning as before, we have $a \times 5 = 5a$ pounds for the answer.

Now, $4x$ is equal to $x + x + x + x$; and $5a = a + a + a + a + a$.

67. *Hence the repeated addition of a quantity to itself is called* MULTIPLICATION. From this definition of multiplication it is manifest that the *product* is a quantity of the same kind as the *multiplicand.*

68. *It is plain, therefore, that multiplying by a whole number is taking the multiplicand as many times as there are units in the multiplier.* Thus multiplying a by 1 is taking the multiplicand *once,* as a.

Multiplying a by 2 is taking the multiplicand *twice,* as $a + a$, etc.

69. *On the other hand, multiplying by a* FRACTION *is taking a certain* PORTION *of the multiplicand as many times as there are like portions of a unit in the multiplier.* Thus:—

Multiplying a by $\frac{1}{2}$ is taking $\frac{1}{2}$ of the multiplicand *once,* as $\frac{1}{2}a$.

Multiplying a by $\frac{2}{3}$ is taking $\frac{1}{3}$ of the multiplicand *twice,* as $\frac{1}{3}a + \frac{1}{3}a$.

70. *Multiplying two or more letters together is writing them one after the other, either with or without the sign of multiplication between them* [see Art. 23, page 21]. Thus b multiplied into c is $b \times c$, or $b \, . \, c$, or bc; and the product of x into y, into z, is $x \times y \times z$, or $x \, . \, y \, . \, z$, or, as it is more commonly written, xyz. Also the product of am into xy is $amxy$; and of abc into xyz, is $abcxyz$.

71. There will be no difference as to the result *in whatsoever order* the letters are arranged. Thus the product of ba is the same as that of ab; and 3 times 5 is equal to 5 times 3. In like manner, the product of a, b, and c, is abc, cab, bac, or cba. It is more convenient, however, to place the letters in *alphabetical* order.

72. *When the letters have numerical* CO-EFFICIENTS, *these must be multiplied together, and prefixed to the product of the letters.*

EXAMPLES.—(1) Multiply $3a$ into $2b$.

Here the answer is $6ab$. For if a into b is ab, then 3 times a into b is evidently $3ab$; and if, instead of multiplying by b, we multiply by *twice* b, the product must be *twice* as great, that is $2 \times 3ab$, which is $6ab$.

	(2)	(3)	(4)	(5)	(6)
Multiply	$12hy$	$3dh$	$2ad$	$7bdh$	$3ay$
By	$2rx$	my	$13ghm$	x	$8mx$
Product:	$24hrxy$	$3dhmy$	$26adghm$	$7bdhx$	$24amxy$

73. If either of the factors consist of figures *only,* these must be multiplied into the co-efficient of the other factor, and the letters annexed. Thus $3ab$ into 4 is $12ab$; 36 into $2x$ is $72x$; and 24 into hy is $24hy$.

From the preceding rules we have the general one, that when factors are to be multiplied the product will be the same in whatever order the operation is performed.

74. If the multiplicand be a *compound* quantity, *each of its terms* must be multiplied into the multiplier. Thus the product of $b + c + d$ into a is $ab + ac + ad$. For the whole of the multiplicand is to be taken as many times as there are units in the multiplier.

EXAMPLES.

(1) Multiply	$d + 2xy$	(2)	$2h + m$
By	$3b$		$6dy$
Product:	$3bd + 6bxy$		$12dhy + 6dmy$
(3) Multiply	$3hl + 1$	(4)	$2hm + 3$
By	my		$4b$
Product:	$3hlmy + my$		$8bhm + 12b$

75. It must be carefully observed that the preceding instances are not to be confounded with those in which several *factors* are connected by the sign $\times$, or by a point. In the latter case, the multiplier is to be written before the other factors *without being repeated.* The product of $b \times d$ into a is $ab \times d$, and not $ab \times ad$; for $b \times d$ is bd, and this into a is abd [Art. 70]. The expression $b \times d$ is not to be considered like $b + d$, a *compound quantity* consisting of two terms. Different terms are always separated by + or − [Art. 19]. The

product of $b \times h \times m \times y$ into a, is $a \times b \times h \times m \times y$, or $abhmy$. But $b + h + m + y$ into a is $ab + ah + am + ay$.

76. If *both* the factors are compound quantities, *each term in the multiplier must be multiplied into each term in the multiplicand.* Thus $(a + b)$ into $(c + d)$ is $ac + ad + bc + bd$. For the units in the multiplier $a + b$ are equal to the units in a, *added* to the units in b. Therefore the product produced by a must be added to the product produced by b. Whence, the product of $c + d$ into $a + b$, is $ac + ad + bc + bd$.

For the product of $c + d$ into a is $ac + ad$; and the product of $c + d$ into b is $bc + bd$ [Art. 75]; therefore the product of $c + d$ into $a + b$ is $ac + ad + bc + bd$.

EXAMPLES.

$$\begin{array}{ll} \text{(1) Multiply} & 3x + d \\ \text{By} & 2a + hm \\ \hline \text{Product:} & 6ax + 2ad + 3hmx + dhm \end{array}$$

$$\begin{array}{ll} \text{(2) Multiply} & 4ay + 2b \\ \text{By} & 3c + rx \\ \hline \text{Product:} & 12acy + 6bc + 4arxy + 2brx \end{array}$$

$$\begin{array}{ll} \text{(3) Multiply} & a + 1 \\ \text{By} & 3x + 4 \\ \hline \text{Product:} & 3ax + 3x + 4a + 4 \end{array}$$

$$\begin{array}{ll} \text{(4) Multiply} & 2b + 7 \\ \text{By} & 6d + 1 \\ \hline \text{Product:} & 12bd + 42d + 2b + 7 \end{array}$$

(5) Multiply $d + rx + h$ by $6m + 4 + 7y$. *Ans.* $6dm + 6mrx + 6hm + 4d + 4rx + 4h + 7dy + 7rxy + 7hy$.

(6) Multiply $7 + 6b + ad$ by $3r + 4 + 2h$. *Ans.* $21r + 18br + 3adr + 28 + 24b + 4ad + 14h + 12bh + 2adh$.

77. When several terms in the product are *alike*, it will be expedient to *set one under the other*, and then unite them by the rules for reduction in addition, as in the following examples:—

$$\begin{array}{lr} \text{(1) Multiply} & b + a \\ \text{By} & b + a \\ \hline & bb + ab \\ & + ab + aa \\ \hline \text{Product:} & bb + 2ab + aa \end{array}$$

$$\begin{array}{lr} \text{(2) Multiply} & b + c + 2 \\ \text{By} & b + c + 3 \\ \hline & bb + bc + 2b \\ & + bc + cc + 2c \\ & + 3b + 3c + 6 \\ \hline \text{Product:} & bb + 2bc + 5b + cc + 5c + 6 \end{array}$$

$$\begin{array}{lr} \text{(3) Multiply} & a + y + 1 \\ \text{By} & 3b + 2x + 7 \\ \hline & 3ab + 3by + 3b \\ & + 2ax + 2xy + 2x \\ & + 7a + 7y + 7 \\ \hline \text{Prod.:} & 3ab+3by+3b+2ax+2xy+2x+7a+7y+7 \end{array}$$

(4) Multiply $3a + d + 4$ by $2a + 3d + 1$. *Ans.* $6a^2 + 11ad + 11a + 3d^2 + 13d + 4$.

(5) Multiply $b + cd + 2$ by $3b + 4cd + 7$. *Ans.* $3b^2 + 7bcd + 13b + 4c^2d^2 + 15cd + 14$.

(6) Multiply $3b + 2x + h$ by $a \times d \times 2x$. *Ans.* $6abdx + 4adx^2 + 2adhx$.

78. It is plain that when the multiplier and multiplicand consist of any quantity *repeated as a factor*, this factor will be repeated in the product as many times as it is in the multiplier and multiplicand together.

$$\begin{array}{ll} \text{EXAMPLE.—Multiply} & a \times a \times a \\ \text{By} & a \times a \\ \hline \text{Product:} & a \times a \times a \times a \times a = aaaaa, \text{ or } a^5. \end{array}$$

Here a is repeated *three times* as a factor in the multiplicand, and twice in the multiplier; hence it is repeated *five times* in the product, and is called the fifth power of a.

EXAMPLES.—(1) What is the product of $bbbb$ by bbb? *Ans.* $bbbbbbb$, or b^7.

(2) What is the product of $aa \times aaa \times aaaa$ by $aaa \times aaaa$? *Ans.* $aaaaaaaaaaaaaaaa$, or a^{16}.

79. It is also plain, from Art. 73, that the *numeral co-efficients* of several factors should be brought together and made into one factor by multiplication. Thus to multiply $2a \times 3b$ by $4a \times 5b$, gives the product of $2a \times 3b \times 4a \times 5b$, or $120aabb$. For the co-efficients are *factors* [Art. 24], and it is immaterial in what *order* these are arranged. Therefore $2a \times 3b \times 4a \times 5b = 2 \times 3 \times 4 \times 5 \times a \times a \times b \times b = 120aabb$.

EXAMPLES.—(1) What is the product of $3x \times 4x \times 5y$ by $2y \times 4z$? *Ans.* $480xxyyz$.

(2) What is the product of $3a \times 4bh$ by $5m \times 6y$? *Ans.* $360abhmy$.

(3) What is the product of $4b \times 6d$ by $2x + 1$? *Ans.* $48bdx + 24bd$.

80. *The product of two or more powers of the same quantity is expressed by writing that quantity with an index equal to the* SUM *of the indices of the proposed powers.* Thus the product of a^2 and a^3 is a^5; and the continual product of x^3, x^4, and x^6 is x^{13}. So likewise the product of x^m and x^n is x^{m+n}, and that of x and x^n is x^{n+1}; and, on the same principle, the product of x^{m-n} and x^n is x^m. The reason of this is evident from Art. 79. Thus a^2 and a^3 are the same as aa and aaa; the

product of which is $aaaaa$ or a^5; the index 5 being the sum of the indices 2 and 3, the numbers which show how often a is used as a factor in the given powers.

EXAMPLES.—(1) What is the product of a^2 and a^5? *Ans.* a^7.

(2) Find the continued product of a^2, ab, and a^4b^2. *Ans.* a^7b^3.

(3) Find the continued product of x^3, x^2y, x^4y^5, and xy^4. *Ans.* $x^{10}y^9$.

RULE FOR SIGNS IN THE PRODUCT.

81. The rule is that $+$ into $+$ produces $+$; $-$ into $+$ gives $-$; $+$ into $-$ gives $-$; and $-$ into $-$ gives $+$; or, in words, *plus* multipled by *plus* gives *plus*; *minus* by *plus* gives *minus*; *plus* by *minus* gives *minus*; and *minus* by *minus* gives *plus*; that is, *if the signs of the factors are* ALIKE, *the sign of the product will be plus, or affirmative; but if the signs of the factors are* UNLIKE, *the sign of the product will be minus, or negative.*

82. The first case, viz., that of $+$ into $+$, needs no explanation, being the same as that of ordinary numbers.

83. The second case is $-$ into $+$, that is, the multiplicand is negative, and the multiplier positive. Thus, $-a$ into $+4$ is $-4a$. For the repetitions in the multiplicand are $-a-a-a-a=-4a$.

EXAMPLES.—(1) Multiply $2a-m$
By $3h+x$
Product: $6ah-3hm+2ax-mx$.

(2) Multiply $h-3d+4$
By $2y$
Product: $2hy-6dy+8y$.

(3) Multiply $a-2-7d-x$
By $3b+h$
Product: $3ab-6b-21bd-3bx+ah-2h-7dh-hx$.

84. In the two preceding cases, the positive sign prefixed to the multiplier shows that the repetitions of the multiplicand are to be *added* to the other quantities with which the multiplier is connected. But in the two remaining cases, the negative sign prefixed to the multiplier indicates that the sum of the repetitions of the multiplicand are to be *subtracted* from the other quantities. This subtraction is performed at the time of multiplying, by making the sign of the product opposite to that of the multiplicand. Thus $+a$ into -4 is $-4a$. For the repetitions of the multiplicand are, $+a+a+a+a=+4a$. But this sum is to be *subtracted* from the other quantities with which the multiplier is connected. It will then become $-4a$ [Art. 58]. Thus in the expression $b-(4\times a)$ it is manifest that $4\times a$ is to be subtracted from b. Now $4\times a$ is $4a$, that is, $+4a$. But to subtract this from b, the sign $+$ must be changed into $-$. So that $b-(4\times a)$ is $b-4a$. And $a\times -4$ is therefore $-4a$.

Again, suppose the multiplicand is a, and the multiplier $(6-4)$. As $(6-4)$ is equal to 2, the product will be equal to $2a$. This is *less* than the product of 6 into a. To obtain, then, the product of the compound multiplier $(6-4)$ into a, we must *subtract* the product of the negative part from that of the positive part. Thus, multiplying a by $6-4$ is the same as multiplying a by 2. And the product of the former, viz., $6a-4a$, is the same as the product of the latter, viz., $2a$. But if the multiplier be $(6+4)$, the two products must be *added*. Thus, multiplying a by $6+4$ is the same as multiplying a by 10. And the product of the former, viz., $6a+4a$, is the same as the product of the latter, viz., $10a$.

This shows at once the difference between multiplying by a *positive* factor and multiplying by a *negative* one. In the former case, the sum of the repetitions of the multiplicand is to be *added to*, in the latter it is to be *subtracted from*, the other quantities with which the multiplier is connected.

EXAMPLES.—(1) Multiply $a+b$
By $b-x$
Product: $ab+b^2-ax-bx$.

(2) Multiply $3dy+hx+2$
By $mr-ab$
Product: $3dmry+hmrx+2mr-3abdy-abhx-2ab$.

(3) Multiply $3h+3$
By $ad-6$
Product: $3adh+3ad-18h-18$.

85. If *two negatives* be multiplied together, the product will be affirmative: $-4\times -a=+4a$. In this case, as in the preceding, the repetitions of the multiplicand are to be *subtracted*, because the multiplier has the negative sign. These repetitions, if the multiplicand is $-a$, and the multiplier -4, are $-a-a-a-a=-4a$. But this is to be subtracted by changing the sign. It then becomes $+4a$.

Suppose $-a$ is multiplied by $(6-4)$. As $6-4=2$, the product is evidently *twice* the multiplicand, that is, $-2a$. But if we multiply $-a$ into 6 and 4 separately, $-a$ into 6 is $-6a$, and $-a$ into 4 is $-4a$ [Art. 83]. As in the multiplier, 4 is to be subtracted from 6; so, in the product, $-4a$ must be subtracted from $-6a$. Now, $-4a$ becomes by subtraction $+4a$. The whole product then is $-6a+4a$, which is equal to $-2a$. Or thus, multiplying $-a$ by $6-4$, is the same as multiplying $-a$ by 2;

and the product of the former, viz., $-6a+4a$, is equal to the product of the latter, viz., $-2a$. Hence the general rule may be thus stated:—*When quantities are multiplied by a positive term, their signs are retained in the product; but when by a negative one, they are changed.*

86. It is often considered a great mystery that the product of two negatives should be affirmative. But it amounts to nothing more than this, that the subtraction of a negative quantity is equivalent to the addition of an affirmative one [Arts. 58, 59], and therefore that the *repeated* subtraction of a negative quantity is equivalent to the *repeated* addition of an affirmative one. So, taking off from a man's hands a debt of ten pounds every month, is adding ten pounds a month to the value of his property.

EXAMPLES.—(1) Multiply $a-4$ into $3b-6$. *Ans.* $3ab-12b-6a+24$.

(2) Multiply $3ab-ah-7$ into $4-dy-hr$. *Ans.* $12ad-4ah-28-3ad^2y+adhy+7dy-3adhr+ah^2r+7hr$.

(3) Multiply $2hy+3m-1$ into $4d-2x+3$. *Ans.* $8dhy+12dm-4d-4hxy-6mx+2x+6hy+9m-3$.

87. Positive and negative terms may frequently *balance* each other, so as to disappear in the product. [Art. 53.]

EXAMPLES.

$$\begin{array}{lcc} & (1) & (2) \\ \text{Multiply} & a-b & mm-yy \\ \text{By} & a+b & mm+yy \\ \hline & aa-ab & mmmm-mmyy \\ & +ab-bb & +mmyy-yyyy \\ \hline \text{Product:} & aa \quad * \quad -bb. & mmmm \quad * \quad -yyyy. \end{array}$$

$$\begin{array}{lr} & (3) \\ \text{Multiply} & aa+ab+bb \\ \text{By} & a-b \\ \hline & aaa+aab+abb \\ & -aab-abb-bbb \\ \hline & aaa \quad * \quad * \quad -bbb. \end{array}$$

88. For many purposes it is sufficient merely to *indicate* the multiplication of compound quantities, without actually multiplying the several terms. Thus [Art. 23], the product of

$$a+b-c \text{ into } h+m+y, \text{ is } (a+b-c)\times(h+m+y).$$

EXAMPLES.—(1) What is the product of $a+m$ into $h+x$ and $d+y$? *Ans.* $(a+m)(h+x)(d+y)$.

By this method of representing multiplication, an important advantage is often gained, in preserving the factors distinct from each other. When the several terms are multiplied in form, the expression is said to be *expanded.*

(2) What does $(a+b)\times(c+d)$ become when expanded? *Ans.* $ac+ad+bc+bd$.

89. With a given multiplicand, the less the multiplier, the less will be the product. If, then, the multiplier be reduced to *nothing*, the *product* will be *nothing*. Thus $a\times 0=0$. And if 0 be one of *any number* of fellow-factors, the product of the whole will be nothing.

EXAMPLES.—(1) What is the product of $ab\times c\times 3d\times 0$? *Ans.* 0.

(2) And $(a+b)\times(c+d)\times(h-m)\times 0$? *Ans.* 0

(3) Multiply $1+x+x^2+x^3+x^4+x^5$ by $1-x+x^2$. *Ans.* $1+x^2+x^3+x^4+x^5+x^7$.

(4) Multiply $1+x+x^2+x^3+x^4+x^5$ by $1-x+x^2-x^3+x^4-x^5$. *Ans.* $1+x^2+x^4-x^6-x^8-x^{10}$.

(5) Multiply $a+2b+c$ by $a-c$. *Ans.* $a^2+2ab-2bc-c^2$.

(6) Find the continual product of $xy-1$, $xz-1$, and $yz-1$. *Ans.* $x^2y^2z^2-x^2yz-xy^2z-xyz^2+xy+xz+yz-1$.

(7) Find the continual product of x^2+yz, y^2+xz, and z^2+xy. *Ans.* $2x^2y^2z^2+x^3y^3+x^3z^3+y^3z^3+xyz^4+xyz^4+x^4yz$.

(8) Multiply $a^2+b^2+c^2-ab-ac-bc$ by $a+b+c$. *Ans.* $a^3+b^3+c^3-3abc$.

From the principles explained in Articles 66 to 89 we derive the following general rule for multiplication:—

90. RULE.—*Multiply the letters and co-efficients of each term in the multiplicand by the letters and co-efficients of each term in the multiplier; and prefix to each term of the product the sign required by the principle, that like signs produce +, and unlike signs −; lastly, unite such terms as are similar.*

Otherwise.—*Multiply every part of the multiplicand by every part of the multiplier, and collect the results as in addition.*

EXERCISE 6.

1. $6ax\times 3ay$.
2. $v^{n+1}\times v^{n-1}$.
3. $v^{m+r}\times v^{n-r}$.
4. $x^5\times x^5$.
5. $x^n\times x^n$.
6. $x^2y^3\times x^5y^2$.
7. $x^3-3x^2y+3xy^2\times axy$.
8. $1-2x+3x^2-4x^3\times 1+x$.
9. $x^2+2ax+a^2\times x^2-2ax+a^2$.
10. $v-2x\times 2x-3z$.
11. Multiply $a+3b-2$ into $4a-6b-4$.
12. Multiply $4ab\times x\times 2$ into $3my-1+h$.
13. Multiply $(7ah-y)\times 4$ into $4x\times 3\times 5\times d$.
14. Multiply $(6ab-hd+1)\times 2$ into $(8+4x-1)\times d$.
15. Multiply $3ay+y-4+h$ into $(d+x)\times(h+y)$.
16. Multiply $6ax-(4h-d)$ into $(b+1)\times(h+1)$.
17. Required the continual product of $a+b+c$, $-a+b+c$, $a-b+c$, and $a+b-c$.
18. Find the product of $x^2-y^2+z^2-v^2\times x^2+y^2-z^2-v^2$.

19. Find the continual product of $2x - y$, $2x + y$, and $4x^2 + y^2$.
20. Multiply $a + b$ into $a + b$ into $a + b$.
21. Multiply $x + y$ into $x - y$ into $x + y$.
22. Multiply $4(x + y)$ into $3a$ into $6b$ into 3.
23. Multiply $3(a + b + c + d)$ into xyz.
24. Multiply $xx + xy + yy$ into $x - y$.
25. Multiply $aaa - bbb$ into $aaa + bbb$.
26. Multiply $aa - ax + xx$ into $a + x$.
27. Multiply $yyy - ayy + aay - aaa$ into $y + a$.
28. Multiply $15a + 20bb$ into $3a - 4bb$.
29. Multiply $3a(x + y) \times 4$ into $a + b$.
30. Multiply $aa + 2ab + bb$ into $a + b$ into $a + b$.
31. Find the product of $x - 2x^2 + 3x^3 \times 4x^4 + 5x^5 - 6x^6$.
32. Find the product of $5y^5 - 7y^4 - 8y^3 + 3y^2 + y \times 7y - 8$.
33. Find the product of $a^3 - 2a^2 + 3 \times a^3 + 2a - 3$.
34. Find the product of $v^4 - 4av^3 + 6a^2v^2 - 4a^3v + a^4 \times v^3 - 3av^2 + 3a^2r - a^3$.
35. Find the product of $x^3 - a^2x + 2a^3 \times x^2 - ax + 2a^3$.
36. Find the continual product of $x - 1$, $x + 2$, $x + 4$, and $x - 5$.
37. Multiply $1 - x + x^2 - x^3 + x^4 - x^5$ by $1 + x + x^2$.

KEY TO EXERCISES.

Exercise 4.

1. $6ab + cd - 4m + 7$.
2. $3y - dx + hm - 1$.
3. $abm + bm - 5y + x + 16$.
4. $8am + 3xy - 11$.
5. $9ahy + 16$.
6. $11ad + xy$.
7. $by + 3(b - a)x + 3a$.
8. $6ax + xy$.
9. $0b + 44cdf - 3xy$.
10. $18a + 4ax - 5bx + 63cx + 3bz - 17xy$.
11. $8ab - 6bc + 4cd - 7xy + 17mn + 18fg - 2ax$.
12. $8abc + 25abd + 5xyz$.
13. $3df + 4ax + 74y + 30$
14. $55a + 68b$.
15. $7(a + b)$.
16. $2xy(a + b)$.
17. $2ax + 5aa + 3x + 3xxx$.
18. $7y + 9yy + 5xy - 6xx$.
19. $9aaa$.
20. $ax^2 + a^2x + xy^2 + 3by^3 + y^3$.
21. $11a^3 - 10a^2b - 14ab^2 + 16b^3$.
22. $10x^3 - 2x^2 + 3x - 2$.
23. $2a + 2b + 2c + 2d$.
24. $a - 6f$.

Exercise 5.

1. $2ab + 4xy + 10dfg$.
2. $-25ax - 6ab - 7m$.
3. $-3ay - 31bx - 9bc$.
4. $2ab - 16xy - 4d$.
5. $11a + 3x + 4df + 18xyz$.
6. $17bc - 42xy + 23gh$.
7. $21ax + y + ac - ay - 4a + bc - x + yz + dc$.
8. $21x + 40xy - 13a + 5bc - 10ab - 42$.
9. $5xy - 29ab$.
10. $13ay - 2ax$.
11. $a + b + c + d - f + g - h - xy$.
12. $13ab + 4xy - 6ad$.
13. $-(a - b + c + d - f - gh)$.

ENGLISH.—XXI.

[*Continued from p. 96.*]

PREFIXES.

En- is a Romance prefix found in English. The Latin *in-* assumed the form *en-* in many French words, and it is through the French that the prefix reached English. *In-*, of course, occurs in English as well as *en-*. Though *en-* and *in-* are the same particle, it may be advisable to handle them separately, in order that their respective usages may become apparent.

En- is found in the forms *en-*, *em-*. The prefix signifies *in* or *into*: *e.g.*—

"He (Samson) rises and carries away the gates wherein they thought to have *en*caged him."—*Bishop Hall.*

So *en*camp, *en*case, *en*chain, *en*chant, *en*close (or *in*close). *En* sometimes has an intensive or augmentative effect on the verb of which it forms a part; as in *en*courage, *en*feeble, *en*kindle (candle), *en*crease (*in*crease), *en*cumber (*in*cumber, from the French *en*combre, Lat. cumulus, *a heap*).

"*En*cumbered soon with many a painful wound,
Tardy and stiff he treads the hostile round;
Gloomy and fierce his eyes the crowd survey,
Mark where to fix and single out the prey."
Rowe, "Pharsalia."

En- has also, though seldom, the force of a negative; as in *en*emy. *Enemy* is from the Latin *inimicus*, where the English *en-* represents the Latin *in-*. Inimicus is made up of in-, *not*; and amicus, *a friend.*

En-, for the sake of euphony, becomes *em-* before *b* and *p*; *em*bitter, *em*blem, *em*bosom, *em*broil, *em*prison (*im*prison), *em*ploy, *em*poverish (*im*poverish).

"At eve within yon studious nook,
I ope my brass-*em*bossèd book,
Pourtrayed with many a holy deed,
Of martyrs crowned with heavenly meed."—*Warton.*

The prefix *en-* also occurs in words directly derived from the Greek. The ultimate origin of *en-* is the same, whether it comes from French or Greek. But in Greek words it comes at first-hand from ἐν. Examples of the prefix *en-* in words derived from Greek: *en*ergy, *em*piric, *en*demic.

Enter- is also a Romance prefix, coming from the Latin (intra, *within*) through the French (entre, *between, among*). It is found in *enter*prise (*enter-*, and Fr. prendre, Lat. prehendere, *to take, to take hold of*), *an undertaking.* It is found also in *enter*tain (Fr. entretenir, Lat. inter- and tenere, *to hold*).

"His office was to give *enter*tainment
And lodging unto all that came and went,
Not unto such as could him feast againe,
And double quite for that he on them spent
But such as waut of harbour did constraine,
Those, for God's sake, his dewty was to entertaine."
Spenser, "Faërie Queene."

Epi-, a prefix of Greek origin, from ἐπί (*ep'-i*), signifying *upon*, as *epi*demic, upon or over (widely spread over) a people. *Epi-* is found in *epi*gram (from the Greek ἐπίγραμμα), *epi*lepsy (from Greek ἐπιληψία), *epi*phany (from Greek ἐπιφάνια), *epi*stle (from Greek ἐπιστολή), etc. etc.

"He that would write an *epi*taph for thee,
And do it well, must first begin to be
Such as thou wert; for none can truly know
Thy worth, thy life, but he that hath lived so."
Donne.

The prefix *epi-* frequently occurs as *ep-* and *eph-*, as in *ep*och, *eph*emeral.

Equi-, of Romance origin (Lat. æquus, *equal*), denoting equality, forms part of several words, as *equi*poise (*equi-* and peser, Fr. *to weigh*; pendĕre, Lat. *to hang*); *equi*vocal (*equi-* and vox, Lat. *a voice*).

"Faith! here's an *equi*vocator that could swear in both the scales against either scale; who committed treason enough in God's sake, yet could not *equi*vocate to heaven; oh, come in, *equi*vocator."—*Shakespeare*, "*Macbeth.*"

Es- is another form of the Romance particle *e-* or *ex-* (q.v.), Lat. e-, ex-. It is in English found in words borrowed from the French, as in *es*calade (*es-* and scala, Lat. *a ladder*), a scaling (of a city), *es*cape (Fr. échapper, *to get away*), *es*cheat (old Fr. escheoir, *to fall due*), a forfeit, *es*chew (old Fr. eschever, *to shun*), *es*cutcheon (*es-* and scutum, Lat. *a shield*).

"Hence without blushing (say whate'er we can)
We more regard the *es*cutcheon than the man;
Yet, true to nature and her instincts, prize
The hound or spaniel as his talent lies."—*Cawthorn.*

Eu-, of Greek origin, signifying *well*, occurs in *eu*phony (from Greek εὐφωνία), *eu*thanasia (εὐθανασία), *a happy death.*

Extra-, of Romance origin, generally found in words derived directly from Latin. It has the meaning *out of*, and appears in *extra*neous, *out of* (not belonging to) the subject; *extra*ordinary (*extra-* and ordo, Lat. *order*), *out of the usual order.*

"Some lands, either because they were in the hands of irreligious and careless owners, or were situate in forests and desert places, or for other now unsearchable reasons, were never united to any parish, and therefore continue to this day *extra*-parochial."—*Blackstone*, "*Commentaries.*"

For-, of English origin, sometimes has an intensive force, sometimes means "away," or, as in *for*bid, reverses the action expressed in the verb. Among examples of words with the prefix *for-* are *for*bear, *for*bid, *for*get, *for*give, *for*lorn, *for*sake.

"Rather how hast thou yielded to transgress
The strict *for*biddance, how to violate
The sacred fruit *for*bidd'n." —*Milton*, "*Paradise Lost.*"

"Phidias, when he had made the statue of Minerva, could not *for*bear to engrave his own name, as author of the piece."—*Dryden.*

Fore-, a different word from the preceding, also of English origin (vor, Germ., *in advance;* vorwärts, Germ., *forwards*), appears in *fore*tell, *fore*cast, *fore*fathers, *fore*head.

"The *fore*knower is not the cause of all that are *fore*known."—*Hammond.*

Hept-, of Greek origin (ἑπτά, *seven*), forms the first syllable of *hept*agon (from Greek ἑπτά and γωνία, an angle), *that which has seven angles*, and consequently seven sides; and *hept*archy (from Greek ἑπτά, and ἀρχία imagined from ἀρχή), *a sevenfold government.* This is a manufactured word, and does not exist in Greek.

"Seven independent thrones, the Saxon *hept*archy, were founded by the conquerors."—*Gibbon.*

Hyper-, of Greek origin (ὑπέρ, *upon, over, too much*), found in *hyper*critic; that is, one who is *too critical*, unjustifiably critical.

"The *hypercriticall* controuller of poets, Julius Scaliger, doth so severely censure nations, that he seemeth to sit in the chaire of the scornfull."—*Camden*, "*Remaines.*"

Hypo-, of Greek origin (ὑπό), with the import of *under*, appears in *hypo*crisy (from Greek ὑπόκρισις), *acting under a mask*, acting an assumed character, involving both simulation or pretending to something you are not, and dissimulation or concealing what you are. *Hypo-* appears also in *hypo*tenuse (from Greek ὑποτείνουσα).

"The square of the *hypotenuse* in a right-angled triangle is equal to the squares of the two other sides."—*Locke*, "*Human Understanding.*"

Hypo- appears also in *hypo*thesis (from Greek ὑπόθεσις), which by its derivation signifies *a placing under*, and so corresponds to the Latin *supposition* (sub, *under;* and ponere, *to place*). An *hypo*thesis, then, is a supposition—something put under certain phenomena or appearances in order to explain their cause or immediate origin.

"Any *hypothesis* which possesses a sufficient degree of plausibility to account for a number of facts, helps us to digest these facts in proper order, to bring new ones to light, and to make *experimenta crucis* (that is, decisive tests) for the sake of future inquiries."—*Hartley*, "*On Man.*"

It also occurs as *hyp-* and *hyph-*, as in *hyp*allage (from Greek ὑπαλλαγή), and *hyph*en (from Greek ὑφ' ἕν, *under one*).

In-, of Romance origin, signifying *in, into*, and *upon*; having also a negative force, appears in these forms—namely, *ig-, il-, im-, in-, ir-, is-.*

Ig-, as in *ig*nore and *ig*noramus. The latter word denotes one who knows nothing. Here *ig-* makes the statement in the verb equivalent to a negative proposition. If ignoramus is given a separate form for the plural, it must stand as ignoramuses; but Beaumont uses ignoramus itself as a plural.

"Give blockheads beere,
And silly *ignoramus*, such as think
There's powder-treason in all Spanish drink."

Ignoramus is used also as an adjective: *e.g.*—

"Let *ignoramus* juries find no traitors,
And *ignoramus* poets scribble satires."

The word is really the first person plural of the present indicative of the Latin verb *ignoro.* It was once a law term, and was written by grand juries on indictments which were "not found."

Il-, as in *il*legal, *not* legal; *il*legitimate, *not* legitimate, the root of both being lex, legis, Latin, *a law.* In *il*lustrate (Latin, lux, *light*), the *il-* denotes *upon; il*lustrate is to throw light *upon* a subject.

Im-, as *im*bibe (Latin bibo, *I drink*), *im*body (*em*body).

"The soul grows clotted by contagion,
Imbodies and *imbrutes*, till she quite lose
The divine property of her first being."—*Milton.*

In *im*bitter, the *im-* (or *em-*) is intensive or augmentative. In *im*mature (Latin, maturus, *ripe*), the *im-* is negative—*im*mature means *unripe; im-* is negative also in *im*memorial (Latin, memor, *mindful*); *immemorial usage* is *usage time out of mind.*

> "And though some impious wits do questions move,
> And doubt if souls *immortal* be or no,
> That doubt their *immortality* doth prove,
> Because they seem *immortal* things to know."

The root of *im*mortal is the Latin mors (mortis in the genitive), *death;* whence mortal.

In-, *in*, as in *in*close (Latin, claudo, *I close*), to shut in; *in-*, *into*, as *in*come; *in-* means also *not*, as *in*cognito (abridged into *incog.*), a word coming to us from the Latin incognitus, *unknown*, through the Spanish *incognito*. *In*convenient is made up of in, *not*, cum, *with*, and venio, *I come; in*convenient, therefore, is that which does not come with you, does not agree with your condition, position, or wishes. In *in*digent (Latin, indigeo, *I want*, from in- and egeo), *needy*, the *in-* is augmentative.

"Themistocles, the great Athenian general, being asked whether he would choose to marry his daughter to an *indigent* man of merit, or to a worthless man of an estate, replied, that he should prefer a man without an estate, to an estate without a man."—*Spectator.*

Ir-, *not*, as in *ir*reparable (from the Latin through the French; Latin, reparare, *to get again*), *not* to be got again, *not* to be regained or restored.

> "Nor does she this *irreparable* woe
> To shipwreck, war, or wasting sickness owe;
> But her own hands, the tools of envious fate,
> Wrought the dire mischief which she mourns too late."
> *Lewis, "Statius."*

In *ir*ruption (Latin, rumpo, *I break*), the *ir-* has the force of *into.*

Inter-, of Latin origin (compare *enter-* as above), signifying *between, among;* as *inter*marry, said of families, members of which marry one another; *inter-* is found also in *inter*polate, *to introduce.* This is a word which has given trouble to the etymologists. Skeat connects it with polire, *to polish.*

"The very distances of places, as well as numbers of the books, demonstrate that there could be no collusion, no altering nor *interpolating* one copy by another, nor all by any of them."—*Bentley, "On Freethinking."*

"The larger epistles of Ignatius are generally supposed to be *interpolated*."—*Jortin, "Ecclesiastical History."*

Intra-, of Latin origin, signifying *within*, occurs in the forms *intra-* and *intro-*—*e.g.*, as in the recent word *intra*mural (Latin, murus, *the wall of a city*), *intra*mural interments, and *intro*duce (Latin, duco, *I lead*), *to lead within;* also *intro*mit (Latin, mitto, *I send*), to *send* or *let in.*

"So that I (Guido Reni) was forced to make an *introspection* into mine own mind, and into that idea of beauty which I have formed in my own imagination."—*Dryden, "Parallel."*

Magn-, of Latin origin (magnus, *great*), in the forms *magn-* and *magni-*, enters into the composition of the following words: *magn*animity (Latin, animus, *mind*), greatness of mind; *magni*fy (Latin, facio, *I make*), to make great, extol; *magni*loquence (Latin, loquor, *I speak*), great talk.

> "To these, thy naval streams,
> Thy frequent towns superb, of busy trade,
> And ports *magnific* add, and stately ships,
> Innumerous."
> *Dyer.*

Mal-, or *male-*, is a Romance prefix, and occurs in words both of French and Latin origin (malum, *evil*), forming a set of words the opposites of words prefixed by *bene-:* as *male*volence, *bene*volence; *male*diction, *bene*diction. *Male-* is also found in *mal*-administration, *mal*treat, *mal*ady, *mal*aria, etc. In *mau*gre it assumes the form *mau-*. This last word in old English as well as in old French meant *ill-will.* Now it means *in spite of.*

> "I have heard
> That guilty creatures sitting at a play
> Have, by the very cunning of the scene,
> Been struck so to the soul, that presently
> They have proclaim'd their *malefactions*."
> *Shakespeare, "Hamlet."*

Meta-, of Greek origin (μετά), signifying *after*, and denoting *change, transference*, is found in *meta*phor (from Greek, μεταφορά), a figure of speech in which there is a transference of a word from its literal meaning. Words originally represented objects of sense. It is only by accommodation or transference that the word which set forth some sensible object has come to denote a state of mind or feeling. Thus acute, which now describes a shrewd, clever mind, properly signifies sharp, piercing—from the Latin acu, *a needle.* From this point of view all words now applied to mental or moral phenomena contain metaphors. Instances may be given in *reflect* (Latin, re-, *back*, and flecto, *I bend*), *abstract* (Latin, ab-, *from*, and traho, *I draw*) *conceive* (Latin, cum-, *with*, and capio, *I take*), and of course their corresponding nouns; also, in hard (*hard* heart), open (*open* disposition), light (*light*-hearted). The term metaphor, however, is specially given to more marked and striking instances of transference, on the ground of some real or supposed resemblance between the material and the mental objects. Thus, the sun is termed *the king of day*, and the moon *the queen of night.*

"An horn is the hieroglyphick of authority, power, and dignity, and in this *metaphor* is often used in Scripture."—*Brown, "Vulgar Errors."*

Meta- forms the two first syllables of *meta*physics (in Greek, μετὰ τὰ φυσικά, *after the physics or natural sciences*). The force of the word will be learnt in these quotations:—

"The one part which is *physic* (physics, relating to matter) inquireth and handleth the material and efficient causes; and the other, which is *metaphysic* (metaphysics, the plural is now generally used), handleth the formal and final causes."—*Bacon*, "*Advancement of Learning.*"

"From this part of Aristotle's logic there is an easy transition to what has been called his *metaphysics*; a name unknown to the author himself, and given to his most abstract philosophical works by his editors, from an opinion that these books ought to be studied immediately *after his physics*, or treatises on natural philosophy." — *Gillies*, "*Analysis of Aristotle's Works.*"

The student should notice that, though *meta-* is a prefix in the Anglicised word metaphysics, it was a preposition in the Greek expression, from which the English word is derived.

Meta-, in the form *met-*, enters into the word *met*empsychosis (from Greek, μετεμψύχωσις), the passage of the soul from one body to another.

"The souls of usurers, after their death, Lucian affirms to be *metempsychosed*, or translated into the bodies of asses, and there remain certain years, for poor men to take their pennyworth out of their bones."—*Peacham.*

Micro-, of Greek origin (μικρός, *little*), is seen in *micro*cosm (Greek, κόσμος, pronounced kos-mos, *the world*)—that is, a little world.

"Because in the little frame of man's body there is a representation of the universal, and (by allusion) a kind of participation of all the parts there, therefore was man called *microcosmos*, or the little world."—*Raleigh*, "*History of the World.*"

Micro- appears also in *micro*scope (Greek, σκοπεῖν, *to look at, see*).

"The works of art do not bear a nice *microscopical* inspection; but the more helps are used, and the more nicely you pry into natural productions, the more do you discover of the fine mechanism of nature."—*Berkeley*, "*Siris.*"

Mid-, of English origin (compare middle), *half-way*, makes a part of several English words, as *mid*land, *mid*night, *mid*day, *mid*ship, *mid*summer; the meaning of which is very plain. *Mid*riff is the diaphragm, the skin or membrane which separates the heart and lungs from the belly. It is derived from *mid-* and *hrif*, Anglo-Saxon for belly.

In some words *mid-* has the meaning of *with.* For instance the word *mid-wife* means *one who is with a woman—i.e.*, a helper of women, especially one who helps women at childbirth.

"Nor need I claim the Muses' *midwifry*,
To bring to light so worthless poetry."—*Bp. Hall.*

Mille-, of Latin origin (mille, *a thousand*), appears in *millen*nium and its derivatives. *Millen*nium (Latin, annus, *a year*) properly signifies a period of a thousand years.

"When at your second coming you appear
(For I foretell the *millenary* year),
The sharpened share shall vex the soil no more,
But Earth unbidden shall produce her store."
Dryden, "*Palæmon and Arcite.*"

Mis-, of English origin, found in the verb to *miss* and in the adverb *amiss*, denoting something wrong, forms a prefix to many words, as *mis*allied, *mis*apply, *mis*become, *mis*conceive, *mis*judge, *mis*like, *mis*represent.

*Mis*give is used in the derivative sense of yielding, weakly yielding, and as yielding weakly, so improperly, the notion of impropriety lying in the *mis-*.

"Great joy he promised to his thoughts, and new
Solace in her return, so long delayed;
Yet oft his heart, divine of something ill,
Misgave him." *Milton*, "*Paradise Lost.*"

There is also another prefix *mis-*. It is of Romance origin, and means *badly.* It may be seen in *mis*alliance, *mis*adventure, *mis*chance, *mis*chief. Its form in French was *mes-*, in Latin, *minus.*

Mono-, *mon-*, of Greek origin (μόνος, *alone*), is to be seen in monachos, *a monk*, one who lives alone; *mon*achism, the society of monks; monas, a *mon*ad, a single object, a unit; *mon*arch (from Greek, μονάρχης), one who rules alone; *mono*gamy (from Greek, γαμεῖν, *to marry*); *mono*polise (from Greek, πωλεῖν, *to sell*), to have the sole power of selling; *mono*theism (Greek, θεος, *God*), the belief in one God; *mono*syllable, a word of one syllable.

"Conjunction, preposition, adverb join
To stamp new vigour on the nervous line;
In *monosyllables* his thunders roll,
He, she, it, and we, ye, they, fright the soul."
Churchill, "*Rosciad.*"

Multi-, of Latin origin (multus, *much*), appears in *multi*farious, of many sorts; *multi*form, of many shapes; *multi*ply (Latin, plica, *a fold*), to take many folds, etc.

"The beauteous lake
The pines wide-branching, falls of water clear,
The *multifarious* glow on Flora's lap
Lose all attraction." *Glover*, "*Leonidas.*"

Neo-, of Greek origin (νέος, *new*). *Neo-* forms the first syllable in *neo*logy, or new science, new doctrine—terms that might be used as fittingly as the Greek word *neology*. *Neo-* is found also in *neo*phyte (Greek, φύτος, *born*), a new-born person, a recent convert.

Non-, of Latin origin, *not*, stands before words of historical importance, as, *non*-conformist, *non*-juror.

"By that Act (the Five Mile Act), passed in the Parliament held at Oxford, October 9, 1665, and entitled, 'An Act for restraining *Nonconformists* (to the Established Church) from inhabiting Corporations, the non-conforming ministers were prohibited, upon a penalty of forty pounds for every offence, to come, unless only in passing upon the road, within five miles of any city, corporation, etc."—*Locke.*

Non-juror is a term usually applied to those persons who refused to take the oaths of allegiance to William III. at the Revolution.

"The *non-juring* prelates were Sancroft, Turner, Lake, Ken, White, Lloyd, Thomas, and Frampton."—*Smollett*, "*History of England.*"

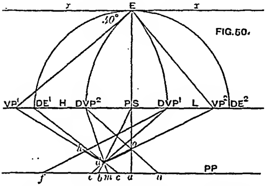
GEOMETRICAL PERSPECTIVE.—VI.

[*Continued from p. 100.*]

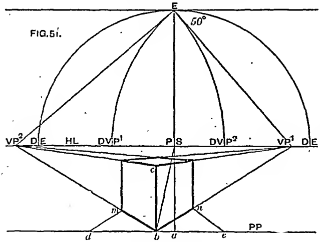
PROBLEMS XXVIII—XXXIV.

PROBLEM XXVIII. (Fig. 50). — *Two lines, each 3 feet long, form a right angle: one of the lines is at an angle of 40° with the* PP, *nearest point 2 feet to the left of the eye, and 1 foot within the picture; height of eye, distance, and scale as in the last problem.*

Draw the PP, horizontal line, and semicircle



through E at the given distance as before, make E VP¹ at an angle of 40° with *x x*, and draw E VP² at a right angle with it. From each of the vanishing points draw arcs from E to the HL for the respective distance points; produce E PS to *a*, and make *a b* equal to 2 feet; join *b* PS, make *b c* equal to 1 foot, and draw a line from *c* to DE¹; where this last line cuts *b* PS in *d* will be the position of the angle; draw a line from *d* to VP¹. Now we must remember the rule given in the last problem, *every vanishing line is cut by its own distance point;* consequently, as DVP¹ is the distance point of VP¹, we must draw a line from DVP¹ through *d* to the PP at *c*, make *c f* equal to 3 feet, the length of one of the lines forming the right angle, and from *f* rule back again to DVP¹, cutting *d* VP¹ in *h; d h* will be the length of the line. The other line of the right angle must be similarly treated; as it vanishes at VP², the *distance point* of VP² must be used for cutting off its perspective length, by bringing a line *first* from DVP² through *d* to the PP at *m;* make *m n* equal to the length of the line, and draw from *n* back again to determine *o* in the vanishing line; *h d o* will be the perspective representation of the right angle as required.



PROBLEM XXIX. (Fig. 51).—*A cube 4 feet side has one of its faces at an angle of* 50° *with the* PP, *its nearest edge touches the picture plane* 1 *foot to the left of the eye; height of eye* 5 *feet; distance from the* PP 8 *feet; scale* 1 *inch to the foot.*

It will be seen that as the nearest angle touches the PP, it will commence at *b*, 1 foot to the left of *a;* and because *b* is a point of contact, its height, *b c*, may be measured from *b; b d* is *equal* to the edge of the cube, 4 feet; its perspective length, *b m*, is cut off the vanishing line *b* VP² by its distance point DVP². The other face of the cube must be treated in the same way; it vanishes at VP¹, therefore the line from *e* to cut off the perspective length *b n* must be drawn to DVP¹; the lines of the horizontal and upper face of the cube will be ruled to their respective vanishing points, as in Fig. 33, Vol. III., p. 346.

PROBLEM XXX. (Fig. 52).—*Draw by this method the flight of steps given on p. 97. There are three, each 4 feet long, 1 foot wide, and 9 inches high; their front making an angle of 40° with the picture plane. The distance of the eye of the observer from the picture plane is 6 feet; from the plane to the nearest point of the object 1 foot: the height of the eye 4·5 feet; scale 1 inch to the foot.*

We will merely go through the order of procedure, until we come to something especially suggested by this problem. Draw the PP; the HL; place the station point, marked E; draw the line from E to find the VP¹ for the angle of inclination of the face with the PP. As the base of the object forms a right angle, the line E VP² must be drawn at a right angle with E VP¹ for the VP of the ends of the steps. Produce E PS to the PP at *a;* the nearest point within is 1 foot; make *a b* equal to 1 foot, and a line from *b* drawn to DE will cut PS *a* in *c*, the nearest point within; draw lines from *c* to each VP, and find their distance points. A line from

DVP^2 must be drawn through c to the PP at c; the widths of the steps will be marked off at f, g, h. Produce VP^2 c to the PP at m, draw the perpendicular $m\ n$ for a measuring line, and upon it

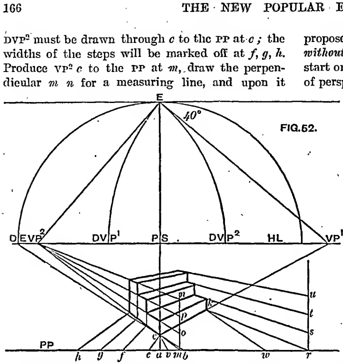


FIG. 52.

mark off the heights of the three steps, o, p, n; rule from these points to VP^2. From the widths of the steps, c, f, g, h, draw lines towards DVP^2, stopping at the vanishing line from c, from which perpendicular lines, made to cut the retiring lines from $o\ p\ n$, will give the respective ends and heights of the steps; from the angles of the steps draw lines towards VP^1. To cut off the lengths of the steps upon the vanishing line c VP^1, draw the line $c\ v$, directed by DVP^1; make $v\ w$ equal to 4 feet, the length of the steps; from w draw back again towards DVP^1, cutting the vanishing line from c in k; draw from k to r, directed by VP^2, from r raise another measuring line for the opposite ends of the steps. Make $s\ t\ u$ equal to $o\ p\ n$, draw lines from them to VP^2; these last lines, intersecting the retiring lines from the tops of the steps, will give the further ends. These slight directions will be quite sufficient for the guidance of those who have thoroughly studied Problem XXVII.

One of the greatest difficulties in geometrical perspective is the treatment of inclined lines and planes. The plan method we have already given is, no doubt, as useful as any, but in some cases the method we are about to explain in this lesson will be found easier and more satisfactory. If the pupil will turn back to Problem XVIII., Fig. 37, p. 31, he will there be reminded how the perspective of an inclined line or plane is obtained by the help of orthographic projection; that is, from a given position of the inclined plane, to produce its plan and elevation, and afterwards from both produce the perspective projection. We now propose to draw the perspective of inclinations *without previously constructing a plan.* We must start once more from one of the leading principles of perspective belonging to *every* system, and which is well known to our pupils—that all horizontal retiring lines and planes have their vanishing points upon the line of sight; to this must now be added: *directly a line or a plane ceases to be horizontal, having one of its ends raised or lowered, its vanishing point is raised or lowered also, for, notwithstanding its inclination, it retires, and has a vanishing point;* therefore the vanishing point of an inclined line or plane is *perpendicularly above the point* to which it retired before it was raised out of its horizontal position—in other words, the position of the *new* vanishing point is according to the angle of the inclination of the line or plane; this brings us to our object, to show where to find the VP, *by constructing the angle.*

PROBLEM XXXI (Fig. 53).—*Give the perspective representation of a pole inclined to the ground at an angle of* 30°. *The plan of the pole is at an angle of* 50° *with the* PP. *Length of pole* 6 *feet; the end on the ground is* 2 *feet within the picture. The distance of the eye from the* PP 8 *feet; its height from the ground* 4 *feet.* First draw the HL, and upon it, from the PS as a centre, draw the semicircle with a radius equal to the distance of the eye from the PP; raise a perpendicular line from PS to E, and through E tangential to the semicircle draw a line parallel to the HL. From E draw a line (E VP) at an angle

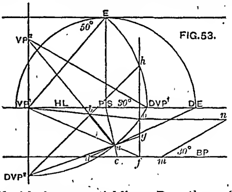
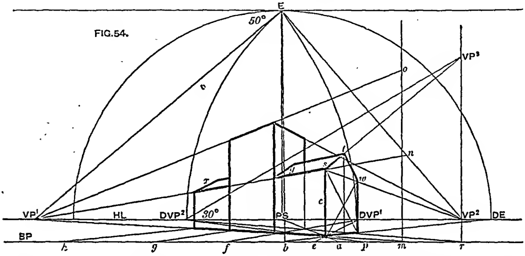


FIG. 53.

of 50° with the tangential line. Draw the BP (base of the picture) parallel to the HL at a distance of 4 feet. Draw PS c, and make $c\ d$ equal to 2 feet; draw a line from d to DE, cutting PS c in a; this will give the point where the pole rests upon the ground. Now if the pole were in a horizontal position, its vanishing point would be at the VP on the HL, but being inclined, its true vanishing point

is above it (if the inclination had been downwards, its vanishing point would have been *below* the HL). Therefore through the VP on the HL draw an indefinite perpendicular line; find the distance point of the VP by drawing the arc E DVP from VP as a centre, and with the radius VP E. From DVP draw a line at an angle of 30°, meeting the perpendicular from VP in VP²; the VP² will be the vanishing point for the inclined line. Through the point *a* draw a line directed to VP and meeting the BP in *f* (the point of contact); from *f* draw the perpendicular *f g h* (the line of contact). Again, the pupil must be reminded of a rule we gave in our last lesson, *that every vanishing line must be cut from its own distance point.* Now the vanishing line in this case is of the pole *only* from *a* to VP², and upon this line we must cut off a portion equal to the length of the pole, consequently we must first find the *distance point* of VP²: thus, from VP² as a centre, and with the distance to DVP on the HL, draw an arc from DVP to DVP². With the use of this distance point we now cut off the length of the pole: draw a line from DVP², through *a*, to the line of contact at *g*; mark off *g h* equal to the length of the pole, 6 feet; and from *h* draw a line back again to DVP², cutting the vanishing line of the pole in *b*; *a b* will be the required perspective representation of the pole. To prove this, draw anywhere upon BP the line *m n*, 6 feet long, and at an angle of 30°; the pupil will see that this is the full length of the pole at the given angle, consequently its height from the ground at *n* is shown; draw *n o* parallel to HL —in other words, mark the height of the pole from the ground upon the line of contact; draw a line from *o* to the VP, it will be found to cut the top of the pole as previously found in *b*. This is one of the problems we recommend our pupils to repeat several times, placing the pole at other angles, and turning it the other way in the picture. A thorough knowledge of the practice of cutting vanishing lines from their distance points is the key-stone of the principle contained in this method of representing objects in perspective. We purpose now to show how this may be applied to give the inclination of a roof, and as it will be necessary to draw the whole figure we will give out the whole problem, and advise that it should be done on a larger scale: our diagram is drawn to a scale of 60 feet to the inch to economise space; it should be drawn by our pupils on a scale of about 10 or 12 feet to the inch.

FIG. 54.



PROBLEM XXXII. (Fig. 54).—*Draw the perspective view of a square tower having wings: the bases of the tower and the wings are each a square of* 48 *feet side; height of tower* 96 *feet, and of the walls of the wings* 48 *feet; the inclination of the roof* 30°, HL 10 *feet, nearest end* 12 *feet within the* PP; *distance of the eye from the* PP, 120 *feet; angle of the front of the building with the* PP, 50°.

Having repeated in the last problem the process which was explained in the last lesson, of finding the PS, E, and HL, the vanishing points and their distance points, we will commence by finding the position of the nearest corner of the building. Draw from PS to *a*; make *a b* equal 12 feet; draw from *b* to D E, the intersection will give the point required, from which a line must be drawn to VP¹. The next part of the process is the stumbling-point of most beginners in this branch of perspective, and we therefore request their attention to it. Find the distance point of VP¹, viz., DVP¹. From DVP¹ draw a line through the nearest corner already

found to the BP at *c;* measure from *c* to *f*, from *f* to *g*, and from *g* to *h*, each distance equal to the lengths of the bases of the wings and tower; rule from these points back again to DVP^1, we shall then have cut the several proportions of the front of the building off the vanishing line—that is, from the nearest angle below *c* to VP^1—by the help of the distance point of VP^1. We make no excuse for repeating this, because we know from practical experience how often this is forgotten. The end of the building must be treated in the same way, beginning with a line from DVP^2 to *p;* *p r* is the width of the building; VP^2 its vanishing point; the heights on the line of contact are at *n* and *o*. We presume there will be no difficulty with the rest of the perpendicular and horizontal lines, and we now proceed with the roof. Because the ridge of the roof is over the centre of the body of the building, there is no necessity in this case for finding more than one vanishing point for the roof, viz., the inclination *s t*. The vanishing point for that inclination is VP^3 on the perpendicular from VP^2, found by making an angle of 30° from DVP^2. The centre of the building is found by drawing the diagonals at the end and a perpendicular through their intersection to *t;* join *t w*, and we have the other or downward side of the roof; the lines *x* and *y* of the roof (in the building itself) are parallel to *s t*, and have the same VP, namely, VP^3.

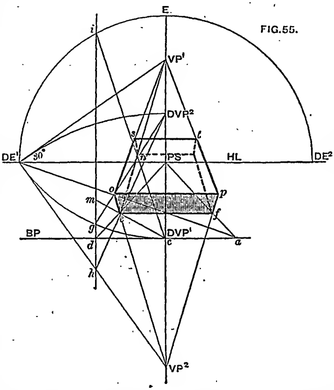


FIG. 55.

Our next problems will have especial reference to *two* inclinations, and will require very close attention.

PROBLEM XXXIII. (Fig. 55).—*A stone slab is inclined at an angle of* 35° *with the ground; it is resting on an edge of one of its ends, which is parallel with the picture plane; the edge on the ground is* 4 *feet within; length of slab* 9 *feet; breadth* 8 *feet; thickness* 2·5 *feet. Height of the eye* 4 *feet; and distance from the* PP 8 *feet.*

Although the slab is on an incline, yet its ends are parallel with the PP, therefore it may be considered a case of parallel perspective; had it been flat on the ground, its vanishing point would have been the PS; but being an incline of 35° its VP is perpendicularly above the PS, found by drawing a line at 35° with the HL from DE^1 (we hope our pupils now clearly understand that the vanishing lines for inclinations are always drawn from the DP of the VP, to which they would retire if they were horizontal; we beg them to turn back and examine the figures of the previous problems to confirm this). The first thing to be done is to find the point *b* within the picture; make *c a* and *c d* each equal to 4 feet (these distances are together equal to the width of the slab); and as *b* is 4 feet within we will use the point *a* again, and rule a line to DE^1; where this line cuts the line *c* PS gives the point *b:* join *d* PS and *a* PS; through *b* draw *e f*. Now, as the face and end of the stone are at right angles with each other, it is very evident that if the vanishing line of the face is at VP^1, the vanishing line of the end must form a right angle with it and terminate at VP^2. Find VP^2, and its distance point DVP^2; through *d* draw the perpendicular *h d g m i*. Now we must draw the *end* of the stone *o e p f* thus: because it vanishes at VP^2, therefore we must draw a line from DVP^2 through *e* to the measuring line in *h;* mark off the thickness of the stone 2·5 feet from *h* to *g*, and rule *g* back again to DVP^2, this gives the perspective thickness of the slab *o e* directed to VP^2. To obtain the opposite corners, *p*, *f*, will present no difficulty: from *c* draw to VP^1, and from the distance point of VP^1 draw a line through *e* to *m* on the measuring line; make *m i* equal to the length of the slab; a line from *i* to DVP^1 will cut the vanishing line *c* to VP^1 in *n;* draw *n s* towards VP^2, and *s t* meeting a line from *p* to the VP^1, this will complete the perspective of the slab. We will now draw the same slab not having any of its sides parallel with the PP.

PROBLEM XXXIV. (Fig. 56).—*The slab of the last problem, having the same dimensions; the position*

only different; one of its edges is at an angle of 40° with the PP; *the remaining conditions as before.*

Draw the HL, BP, distance E, and semicircle. Find the VP for the end, viz. VP^1, by a line from E at an angle of 40° with the tangent line. VP^2 is found by drawing a line at a right angle with EVP^1; draw E PS b; bc is the distance of the nearest point within, determining a (remember DE is the distance point for cutting the line b PS to find a). The vanishing point for the face of the slab will be VP^3, found by drawing a line from DVP^2 at an angle of 30°; VP^4 will be the vanishing point for

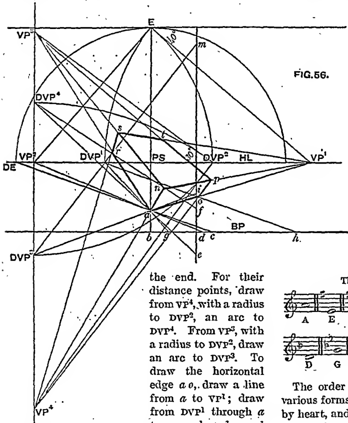


FIG. 56.

the end. For their distance points, draw from VP^4, with a radius to DVP^2, an arc to DVP^4. From VP^3, with a radius to DVP^2, draw an arc to DVP^3. To draw the horizontal edge $a\,o$, draw a line from a to VP^1; draw from DVP^1 through a to g; make $g\,h$ equal to the width; from h rule back again to DVP^1, giving the required length of the end $a\,o$. Through a draw from DVP^4 to e on the measuring line, $e\,f$ is equal to the thickness of the slab; draw from f to DVP^4, and through a directed to VP^4 draw $a\,n$; draw from n to VP^1. Through o draw $o\,p$ directed to VP^4; this will be the *end* of the slab. Draw from a to VP^3; through a from DVP^3 draw a line to i; make $i\,m$ equal to the length of the slab; draw from m back again to DVP^3, this will produce $a\,r$. Draw a line from n to VP^3 for the inclined edge. A line directed from VP^4 through r, meeting the line from n to VP^3 in s, will be the termination of the length. From s to t, directed to VP^1, will be the upper edge of the face of the slab.

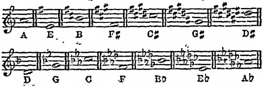
MUSIC.—XXI.

[*Continued from p. 83.*]

(STAFF NOTATION.)

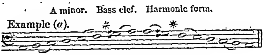
THE MINOR KEY.

ALL the major keys have their pendant minors starting from *lah*, the third below the major. The singer must take care to avoid the confusion of regarding the key-note of the minor as *doh*. It must be called *lah*, otherwise sol-faing on the movable *doh* principle becomes impossible. There is no special signature for the minor key. Each minor key has the signature of the major key starting on the third above. Minor keys are named from the pitch of the *lah*, with the added qualification "minor." It is easy to see for what minor key a signature stands if the major key signatures are thoroughly known. Knowing where *doh* is with any given major key signature, the minor key shown is the minor third below. Thus the signature of A major is also the signature of F♯ minor.

The Signatures of the Minor Keys.

The order of tones and semitones, etc., in the various forms of the minor scale should be learned by heart, and written out from all pitches. Examples are here given to serve as models.

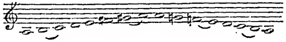
A minor. Bass clef. Harmonic form.

Example (*a*).



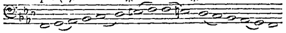
A minor. Treble clef. Harmonic form.

Melodic forms.

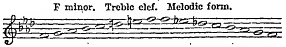


F minor. Bass clef. Harmonic form.

Example (*b*). * *



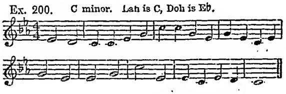
F minor. Treble clef. Melodic form.

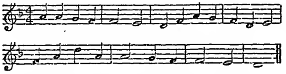
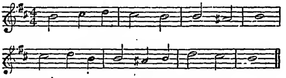
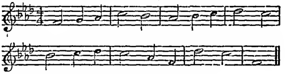


* Augmented seconds. (*See* p. 174.)

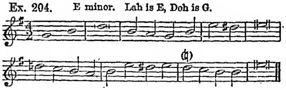
The following exercises should be sung:—

Ex. 200. C minor. Lah is C, Doh is E♭.



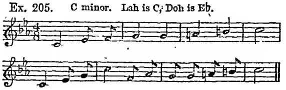
Ex. 201. D minor. Lah is D, Doh is F.

Ex. 202. B minor. Lah is B, Doh is D. Soh ♯ is *se*.

Ex. 203. F minor. Lah is F, Doh is A♭.

It is difficult to sing *soh* soon after *se*.

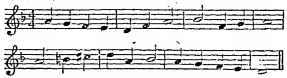
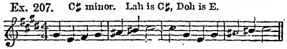
Ex. 204. E minor. Lah is E, Doh is G.

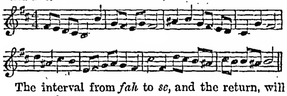


See directions over Ex. 191, Tonic Sol-fa, above.

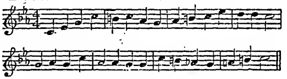
Ex. 205. C minor. Lah is C, Doh is E♭.



Ex. 206. D minor. Lah is D, Doh is F.

Ex. 207. C♯ minor. Lah is C♯, Doh is E.

Ex. 208. B minor. Lah is B, Doh is D.



The interval from *fah* to *se*, and the return, will require extreme care.

Ex. 209. C minor. Lah is C, Doh is E♭.

RELATIVE MINOR AND MAJOR.

Major and minor scales that have *dohs*, *lahs*, etc., of the same pitch are said to be RELATIVE.

Relative major d r m f s l t d^1.
l_1 d r m f se l Relative minor.

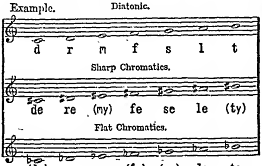
In the Staff notation the relatives are those minor and major scales that have the same signature. Thus one flat on B forms the signature of F major and its relative minor D, and three sharps form the signature of F sharp minor and its relative major A.

CHROMATIC TONES AND NAMES.

The tones of the major scale formed by the chords of *doh*, *soh*, and *fah* (*i.e.*, d r m f s l t), are termed DIATONIC tones. In the minor mode, *fah*, *soh*, *bay*, and *se* are considered to be diatonic tones. Besides these diatonic tones, composers are in the habit of using tones between the whole tones of the diatonic scale. The sharp fourth (*fe*) and the flat seventh (*ta*) may be regarded as types of these effects. All such tones are generally classified as CHROMATIC TONES. Sometimes these chromatics are named from the diatonic below, and sometimes from the diatonic above. Chromatics are threatened changes of key "nipped in the bud." The true notation of chromatics is regulated by the key they threaten. Thus the tone between *te* and *lah* is almost invariably made by the context to sound like the *fah* of the first *flat* key, and is

therefore named as a flat of the diatonic above. Similarly, the tone between *fah* and *soh* is named as a sharp because it sounds like *te* of the first *sharp* key. But the convenience of singers and players often overrules this principle, and chromatics are named as sharps when they lead upward, and as flats when they lead downward. The names for chromatics are formed on the model of *fe* and *ta*; that is, for sharps "*e*," and for flats "*a*" (pronounced *aw*) are added to the initial letters of the diatonic tones sharpened or flattened.

Example.



RARE CHROMATICS.

The sharp of *bay* in the minor is sometimes required. It is called *be*. The flat of *soh* (*sa*) is seldom or never required. And the flats of *doh* and *fah*, as well as the sharps of *me* and *te*, are not needed in practice, because the pitch they indicate is already indicated by the contiguous diatonic. The use of these names is exclusively confined to theory.

PRACTICE OF CHROMATICS.

The chromatics that call for most practice because of their frequent use are the sharps, *de*, *re*, *fe*, *se*, and the flats *ta*, *la*, and *ma*. *Lah* sharp (*le*) and *ray* flat (*ra*) are rarely used in vocal music. Sharp chromatics are best studied in connection with the diatonic tone above and flats in connection with the tone below (except in the case of *ta*). When this connection is well established they should be approached and quitted by leap. Great assistance will then be gained by observing the distinctive mental effect of each chromatic, derived from its partial relation to the new key threatened and to the key already established.

(TONIC SOL-FA NOTATION.)

The modulator given below will enable the Tonic Sol-faist to clearly see the most used changes of key and mode and the positions of chromatic notes. The enharmonic "equivalents" (see p. 174) do not correspond exactly because, strictly, they are not alike in pitch. These shades of difference, however, should give no conscious concern to the singer. The melodic and harmonic surroundings of a note enable him to instinctively make the minute differences really called for. A keyed instrument, owing to its construction, is at best a little out of tune with itself. But, fortunately for the art of music, our ears accept compromises, and we are tolerant of small discrepancies of pitch, and actually take notes for what they pretend to be rather than for what they are.

THE MODULATOR.

r^1	s	d^1	f^1			
		t	m^1	l	r^1	s
d^1	f					
t	m	l	r^1	s	d^1	f
					t	m
l	r	s	DOH^1	f		
			TE	m	l	r
s	d	f	ta le			
	t_1	m	LAH	r	s	d
f			la se			t_1
m	l_1	r	SOH	d	f	
			ba fe	t_1	m	l_1
r	s_1	d	FAH			
		t_1	ME	l_1	r	s_1
d	f_1		ma re			
t_1	m_1	l_1	RAY	s_1	d	f_1
			ra de		t_1	m_1
l_1	r_1	s_1	DOH	f_1		
			t_1	m_1	l_1	r_1
s_1	d_1	f_1	ta_1			
	t_2	m_1	l_1	r_1	s_1	d_1
f_1			se_1			t_2
m_1	l_2	r_1	s_1	d_1	f_1	
			fe_1	t_2	m_1	l_2
r_1	s_2	d_1	f_1			
		t_2	m_1	l_2	r_1	s_2

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EXERCISES ON SHARP CHROMATICS.

s fe s or d t_1 d form a model of the easiest approach to the other sharp chromatics. The following exercise introduces all the sharps in an easy manner. It should be thoroughly memorised.

Ex. 196. *Doh* is D.

|d :t_1 :d |r :de :r |m :re :m |f :m :f }

|s :fe :s |l :se :l |t :le :t |d^1 :— :— ||

Ex. 197. *Doh* is F. *De and re approached from above.*

|d :m |s :m |m :r |de:r |de:r |de:r }
|m :r |d :— |m :s |f :m |re:m |re:m }
|l :m |re:m |f :t_1 |d :— ||

Ex. 198. *Doh* is E♭. *De and re approached from below.*

|d :m :r |d :— :de |r :f :m |r :— :re }
|m :f :fe |s :m :d |d :t_1 :d |r :— :re }
|m :f :s |l :d :de |r :m :r |d :— :— ||

Ex. 199. *Doh* is D♭. *Le and se approached from above.*

|m :s |d^1:s |d^1:t |le:t |t :l |se:l }
|s :f |m :— |m :d^1 |t :le |t :l |l :s }
|l :se |l :s |f :t_1 |d :— ||

Ex. 200. *Doh* is G. *Le and se approached from below.*

|d :t_1 |t_1 :l_1 |s_1 :se_1 |se_1:l_1 |l_1 :le_1 |t_1 :t_1 }
|d :m |r :— |m :l_1 |le_1:t_1 |f :t_1 |t_1 :d }
|s_1 :se_1 |l_1 :le_1 |t_1 :t_1 |d :— ||

LEAPS TO AND FROM SHARP CHROMATICS.

Ex. 201. *Doh* is C.

|m :s :m |r :de :r |s :f :de |r :— :re }
|m :re :m |l :re :m |f :l :re |m :— :— }
|d^1 :s :se |l :m :l |d^1:se :l |r^1 :— :— }
|r^1 :se :l |f :m :re |m :de :r |d :— :— ||

Ex. 202. *Doh* is F.

|d :r |m :re |m :s |re:m |r :de |f :m }
|re:l |se:s |fe :f |m :re |m :r |de:m }
|f :fe |l :s |se:se |t :l |r :re |m :de }
|m :r |d :— ||

EXERCISES ON FLAT CHROMATICS.

Ex. 203. *Doh* is D. *Ta and ma.*

|d :m |s :d^1 |ta:l |t :d^1 |d :r |ma:r }
|m :f |s :— |s :ta |l :s |r :ma |r :r }
|m :s |f :d |m :r |d :— ||

Ex. 204. *Doh* is E♭. *La (Lah flat).*

|d :m :s |s :— :s |la:s :s |la:s :s }
|l :t :d^1 |s :m :d |m :— :r |d :— :— ||

FLATS APPROACHED FROM OR FOLLOWED BY THE DIATONIC ABOVE.

Ex. 205. *Doh* is F.

|d :t_1 |ta_1:l_1 |d :m |ma:r |m :f |s :s }
|l :la |s :— |s :m |ma:r |r :ma |m :r }
|s :la |l :l_1 |t_1 :t_1 |d :— ||

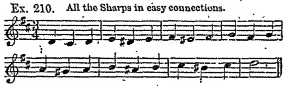
Ex. 206. *Doh* is G. *Ra (Ray flat).*

|d :t_1 |d :m |d :ra |ra:d |d :m |s :m }
|d :ra |d :— ||

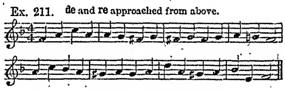
(STAFF NOTATION.)

EXERCISES ON SHARP CHROMATICS.

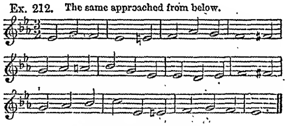
Ex. 210. All the Sharps in easy connections.



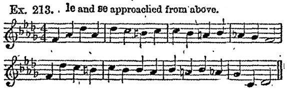
Ex. 211. de and re approached from above.

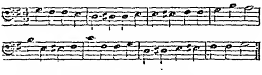
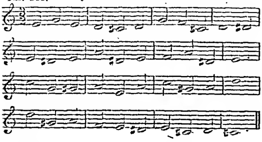
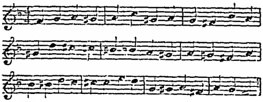


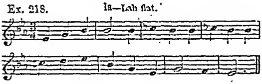
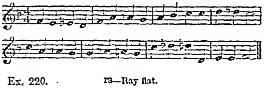
Ex. 212. The same approached from below.

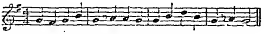


Ex. 213. le and se approached from above.



Ex. 214. Bass clef. The same approached from below.

Ex. 215. Leaps to and from Chromatics.

Ex. 216.

Ex. 217. Bass clef. ta and ra.

Ex. 218. la—Lah flat.

Ex. 219. Flats approached from above.

Ex. 220. ra—Ray flat.



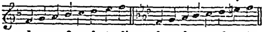
THE TONIC MINOR AND TONIC MAJOR.

The relations of minor and major keys were partially explained on p. 170. Another important relation still remains to be explained. Until recent times composers nearly always gained contrasts of minor and major keys by following a major key by its relative minor, or a minor key by its relative major. But in modern music it is easy to observe that the tendency is to obtain a more forcible contrast of the two modes by following a minor key by a major key or a major key by a minor key, starting from the same point of pitch. Modes so related are said to be in the TONIC MAJOR or the TONIC MINOR. Some writers consider this relation a closer affinity than that described as the relative minor or major, and they regret the conventional use of the term *relative*, because they consider it misleading.

EXAMPLES OF TONIC MINOR AND TONIC MAJOR RELATIONS.

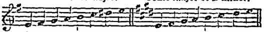
Example.

Tonic major of F minor. Tonic minor of F major.



$d\ r\ m\ f\ s\ l\ t\ d'$ $\quad l_1\ t_1\ d\ r\ m\ f\ se\ l$

Tonic minor of E major. Tonic major of E minor.



$l_1\ t_1\ d\ r\ m\ f\ se\ l$ $\quad d\ r\ m\ f\ s\ l\ t\ d'$

Staff notationists can practise this change by pointing on the Transition Diagram (p. 81). It will be seen that a change from major to tonic minor involves three more flats or their equivalents in the signature, and a change from minor to tonic major three more sharps or their equivalents. Hence this change is often termed *three removes.* The Tonic Sol-faist can trace three removes by pointing on the seven-column modulator given on p. 171. In printed Tonic Sol-fa notation the column to which a change of key carries the singer is clearly indicated by the number of *distinguishing tones* (*see* p. 16) which are placed on the right or left of the new key name.

Example:—

Doh is C. (1) s.d.f.E♭ (2) C.t.m.l. (3) D.t.m. (4) d.f.C.

$d\ t_1\ d\ m\ {}^{s}m\ f\ m\ r\ d\ {}^{t_1}r\ m\ f\ m\ {}^{r}d\ t_1\ d\ m\ {}^{f}s\ f\ m\ r\ d$

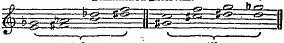
(1) Three removes to the left; (2) three to the right; (3) two to the right; (4) two to the left.

CHROMATIC INTERVALS.

The use of chromatics leads to the creation of interval distances not shown by the diatonic tones. All intervals that cannot be properly expressed by diatonic tones are regarded as CHROMATIC INTERVALS, and are named on the following plan: Intervals smaller than minor or perfect are called DIMINISHED, and larger than major are called AUGMENTED.

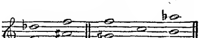
Examples of Chromatic Intervals.

Diminished Intervals.



3rds. 4ths.

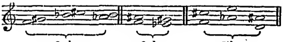
sa la ra' f' d' f' s' sa'
m fe t re' se de' re' r'



6ths. 7ths.

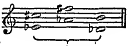
ra' f' f' d' la'
f le se re t

Augmented Intervals.



2nds. 3rds. 5ths.

se de' t le se de' m' le
f ta la f ma f la r



6ths.

de' fe' t
ma la ra

Writing Exercises on Chromatic Intervals.

(Tonic Sol-fa Notation.)

Ex. 207.—Write (*a*) the diminished 3rd above de, re, se, le; and (*b*) the diminished 4th above the same chromatics; and (*c*) the diminished 7th *below* d^1, ta, la, s, f, ma, and ra.

Ex. 208.—Write (*a*) the augmented 2nd above d, ra, ma, s, la; (*b*) the augmented 3rd above ra, la, and ta; (*c*) the augmented 5th above ra, ma, ta_1, and d; and (*d*) the augmented 6th above d, f, and ta_1.

(Staff Notation.)

Ex. 221.—Write (*a*) the diminished 3rd above A♯, C♯, and G♯; (*b*) the diminished 4th above A, B, C^1, and E; (*c*) the diminished 7th below E♭, D♭, B♭, and G♭.

Ex. 222.—Write (*a*) the augmented 2nd above G, A, D♭, E♭, and A♭; (*b*) the augmented 3rd above B♭, A♭, G♭; (*c*) the augmented 5th above G, E, A, and G♭; (*d*) the augmented 6th above F, B♭, and C♭.

Enharmonic Changes and Equivalents.

Notes showing practically the same pitch, but having different names, are said to be ENHARMONIC EQUIVALENTS. Thus C♯ and D♭, B♭ and A♯, or *se* and *la*, *re* and *ma* are enharmonic equivalents. In the Staff notation, where modulations would involve the use of distracting double sharps or flats, composers simplify notation by using an enharmonic equivalent. Thus if a piece of music modulated to a key four flat removes from the key of D♭—which would be B double ♭—it would be an easier expression of this pitch to write in the key of A, with three sharps for its signature.

Reading Accidentals.

It is often difficult to make out quickly whether an accidental points to a change of key or a change to the minor, or whether it is a chromatic note of the key established. Only long experience as a reader and the most careful study of theory can give the singer power to fluently read music in which accidentals abound. The following general rules will be found useful.

Rules for Sol-faing Accidentals.

1. Prefer not to change key until compelled. That is, go on naming in the starting key of the piece, using chromatic names until some new key is obviously established.

2. If there are many accidentals try to group them to form a "signature," and sol-fa accordingly.

3. Examine the piece before singing, and mark the key changes or other difficulties.

4. In choral music cultivate the power of observing other parts besides your own.

5. Cultivate the power of seeing what interval separates notes and learn by frequent practice good models of all the common intervals (*e.g.*, *doh* to *me* is a good model of a major third). Practice recitatives from oratorios and operas: they generally start with an "open" signature and contain many accidentals.

Conclusion.

The object of this course of lessons has now been accomplished. If the student has fairly grasped all that has been taught he will, at least, have a practical knowledge of the fundamental facts of music, and it may be hoped he will be encouraged to pursue the study much further. There is no end to the study of music. The greatest musicians declare that they are always learning something. Whether your further studies are in the direction of vocal or instrumental music, or of harmony, instrumentation, or composition, try all you can to form your musical taste by a close acquaintance with the works of the most eminent composers, and by listening to the best executants.

FRENCH.—XXI.

[*Continued from p. 109.*]

INDEFINITE ADJECTIVES.

THE indefinite adjectives are used when anything is to be represented or referred to in a general or indefinite manner. They are :—

aucun,	*not any, not one.*	plusieurs,	*several.*
autre,	*other.*	quantes,	*every.*
certain,	*certain.*	quel,	*what.*
chaque,	*every, each.*	quelconque,	*whatever.*
maint,	*many.*	quelque,	*some.*
même,	*same.*	tel,	*such.*
nul,	*no.*	tout,	*all.*
pareil,	*such.*		

Aucun, f. *aucune*, is generally followed by a noun, with which it must agree. It requires *ne* before the verb :—

aucun homme, *no man ;*	*aucune* femme, *no woman.*
Aucun chemin de fleurs *ne* conduit à la gloire. LA FONTAINE.	*No flowery path leads to glory.*
On méprise tous ceux qui n'ont *aucune* vertu. LA ROCHEFOUCAULD.	*All those who have no virtue are despised.*

Aucun is by some French authors sometimes used in the plural :—

Ils ne peuvent souffrir aucun empire légitime, ne mettent *aucunes* bornes à leurs attentats. MONTESQUIEU.	*They can bear no legitimate dominion, set no bounds to their crimes.*

Aucun was spelt *alcun* in the 13th century, and this spelling renders its derivation from the Latin *aliquis* quite intelligible.

Autre (from Latin *alter*), *other*, is common gender, and may take the mark of the plural. It is also used substantively with or without a reference to a noun :—

J'ai acheté un *autre* cheval.	*I have bought another horse.*
Voici le premier volume de votre histoire d'Angleterre, où sont les deux *autres ?*	*Here is the first volume of your English history, where are the two others ?*

Certain, f. *certaine* (from Latin *certus*), is in this sense always placed before its noun :—

Certain renard . . . . LA FONTAINE.	*Certain fox . . . .*

Chaque is of both genders, and is used only in the singular. It always precedes the noun, and should never be used without one :—

Chaque âge a ses plaisirs; *chaque* état a ses charmes. DELILLE.	*Every age has its pleasures, every situation its charms.*

In old French *chaque* was spelt *chesque*, and even *quesque*, and this reveals its derivation from the Latin *quisque*.

Maint, f. *mainte*, may be used in the singular or in the plural, and repeated before its noun :—

Je l'ai dit *mainte* fois.	*I said it many a time.*
Maints et *maints* travaux.	*Very many works.*

Même, placed before the noun, has the sense of *same* in English. Placed after the noun, it means, generally, *himself, herself, itself*, or *themselves*. It is sometimes used as an adverb, when it may be rendered by the word *even*. As an adjective, *même* is common gender, but may take the mark of the plural :—

C'est la *même* vertu } *It is the same virtue* }	C'est la vertu *même*. } *It is virtue itself.* }
Le peuple et les grands n'ont ni les *mêmes* vertus, ni les *mêmes* vices. VAUVENARGUES.	*The people and the great have neither the same virtues nor the same vices.*
Il lui donna *même* ses habits.	*He gave him even his clothes.*

Nul is a stronger negative than *aucun*. It agrees in gender and number with the noun which it qualifies. Like *aucun*, it requires *ne* before the verb :—

Nul homme n'est heureux; *nulle* chose ne peut le rendre tel. BOISTE.	*No man is happy ; nothing can render him so.*
Nulle paix pour l'impie; il la cherche, elle le fuit. RACINE.	*No peace for the impious ; he seeks it, it avoids him.*

Nul is sometimes used absolutely in the sense of *no one :*—

Nul n'est content de sa fortune, ni mécontent de son esprit. MME. DESHOULIÈRES.	*No one is pleased with his fortune, nor displeased with his own wit.*

Note.—*Nul* modifies its meaning according as it precedes or follows its noun.

Plusieurs is common gender, and always in the plural :—

Il faut bien qu'il y ait *plusieurs* raisons d'ennui, quand tout le monde est d'accord pour bâiller. FLORIAN.	*There must necessarily be several reasons for ennui, when all agree in yawning.*

Plusieurs may be used as a pronoun with or without reference to a noun :—

Il n'a qu'un frère, mais moi j'en ai *plusieurs*.	*He has but one brother, but I have several.*
Plusieurs l'ont cru.	*Many believed it.*

Pareil, f. *pareille*, is chiefly used in exclamatory sentences :—

Comment a-t-il pu commettre une faute *pareille ?*	*How could he commit such a fault ?*

Quantes is only used in the feminine plural with the word *fois :*—

Toutes et *quantes* fois, *or* toutes fois et *quantes*.	*Every time ; whenever.*

Quel, f. *quelle*, takes the gender and number of the noun to which it relates. It is sometimes immediately followed by its noun, from which it may be separated by one or several words :—

Quel tableau ravissant présentent les campagnes ! DELILLE.	*What a delightful picture the country offers !*
Quelle invisible force a soumis l'univers ! RACINE.	*What invisible hand has conquered the universe !*
Quels sons harmonieux, *quels* efforts ravissants, De la reconnaissance égalent les accents !	*What harmonious sounds, what ravishing strains, equal the voice of gratitude !*

Quelconque is always placed after the noun, and varies only for the plural :—

Toutes les jouissances sont précédées d'un travail *quelconque.* MME. CAMPAN.	*All enjoyments are preceded by some sort of exertion.*
Deux points *quelconques* étant donnés . . . THE ACADEMY.	*Two points whatsoever being given . . .*

Quelque, in the sense of *some* (*a certain number*), or *whatever*, agrees in number with the noun:—

Il y a du mérite sans élévation, mais il n'y a point d'élévation sans *quelque* mérite. LA ROCHEFOUCAULD.	*There is merit without elevation, but there is no elevation without some merit.*
Quelques vains lauriers que promette la guerre, On peut être héros sans ravager la terre. BOILEAU.	*Whatever vain laurels war may promise, one may be a hero without ravaging the earth.*

But when *whatever* precedes a noun subject of the verb *to be*, it is expressed in French by two words, viz., *quel*, which agrees in gender and number with the noun, and the conjunction *que;* in this case the verb is used in the subjunctive, and placed before its subject:—

Quels que soient ses projets.	*Whatever his projects may be.*
Quelle que soit votre intention.	*Whatever your intention may be.*

Quelque used adverbially, in the sense of *about*, or *some*, or *however*, is invariable:—

Quel âge avez-vous? Vous avez bon visage. Eh! *quelque* soixante ans. RACINE, *Les Plaideurs.*	*How old are you? You look well. Oh! some sixty years.*
Alexandre perdit *quelque* trois cents hommes, quand il vainquit Porus. D'ABLANCOURT.	*Alexander lost some three hundred men when he vanquished Porus.*
Quelque méchants que soient les hommes, ils n'oseraient paraître ennemis de la vertu. LA ROCHEFOUCAULD.	*However wicked men may be, they do not dare to appear enemies of virtue.*

Tel, f. *telle*, agrees with the noun which it qualifies:—

tel livre, *such book.*	*telle* lettre, *such letter.*
tels livres, *such books.*	*telles* lettres, *such letters.*

In reference to persons it is sometimes used as a pronoun:—

Tel qui rit aujourd'hui	*Such as laughs to-day . . . .*

Tout, meaning *every*, is always in the singular, but varies for the feminine:—

Tout citoyen doit servir son pays; le soldat de son sang, le prêtre de son zèle. LA MOTTE.	*Every citizen should serve his country; the soldier with his blood, the priest with his zeal.*
En *toute* chose, il faut considérer la fin. LA FONTAINE.	*In everything we must consider the end.*

Tout, in the sense of *all*, agrees in gender and number with the noun to which it relates:—

tout l'argent, *all the money.*	*toute* la toile, *all the cloth.*
Il était au-dessus de *tous* ces vains objets qui forment *tous* les désirs et *toutes* les espérances des hommes. MASSILLON.	*He was above all those vain objects which form all the desires and all the hopes of men.*

As an adjective, *tout* loses its final *t* in the masculine plural, which is *tous;* but preserves it when it is used substantively:—

Plusieurs *touts* distincts.	*Several distinct wholes.*

THE PRONOUN.

The pronoun in French, as in other languages, is a word used to represent the noun, in order to prevent its too frequent repetition.

The pronoun serves also to designate the parts which each person or thing takes in speech. This part is called *person.*

There are three persons—the first, or that which speaks; the second, or that spoken to; the third, or that spoken of.

There are five sorts of pronouns:—

The Personal.	The Demonstrative.
The Possessive.	The Relative.
The Indefinite.	

THE PERSONAL PRONOUN.

The personal pronouns are so called because they designate the three persons more especially than the other pronouns.

These pronouns are:—

	Nominative Form. Singular.	*Nominative Form.* Plural.	*Reflexive Form.* Singular.	*Reflexive Form.* Plural.
1.	je, *I;*	nous, *we.*	me, *myself;*	nous, *ourselves.*
2.	tu, *thou;*	vous, *you, ye.*	te, *thyself;*	vous, *yourselves.*
3.	il, *he, it,* m.;	ils, *they,* m.	se, soi, *himself; herself; itself;*	se, *themselves.*
	elle, *she, it,* f.;	elles *they,* f.		

Direct Object (Accusative).

When placed before the verb—

	Singular.	*Plural.*
1.	me, *me;*	nous, *us.*
2.	te, *thee;*	vous, *you.*
3.	le, *him, it,* m.; la, *her, it,* f.;	les, *them,* m. f.
	se, *himself, herself, oneself, itself;*	se, *themselves, one another, each other,* m. f.

When placed after the verb—

Singular.	*Plural.*
moi, *me;*	nous, *us.*
toi, *thee;*	vous, *you.*
le, *him, it,* m.; la, *her, it,* f.;	les, *them,* m. f.

Indirect Object (Dative).

When placed before the verb—

	Singular.	*Plural.*
1.	me, *to me;*	nous, *to us.*
2.	te, *to thee;*	vous, *to you.*
3.	lui, *to him; to her; to it;*	leur, *to them* (both genders).
	se, *to himself; to herself; to oneself; to itself;*	se, *to themselves. to one another. to each other.*

When placed after the verb—

Singular.			*Plural.*		
moi,	à moi,	*to me;*	nous,	à nous,	*to us.*
toi,	à toi,	*to thee;*	vous,	à vous,	*to you.*
lui,	à lui,	*to him;*	leur,	à eux, m. à elles, f.	*to them.*
	à elle,	*to her;*			
soi,	à soi,	*to himself; to herself; to oneself; to itself;*			

Genitive and Ablative.

Always placed after the verb—

Singular.			Plural.		
de moi,	*of or from*	*me;*	de nous,	*of or from*	*us.*
de toi,	"	*thee;*	de vous	"	*you.*
de lui,	"	*him;*			
d'elle,	"	*her;*			
de soi,	"	*himself; herself; oneself; itself;*	d'eux,	"	*them,* m.
			d'elles,	"	*them,* f.

REMARKS ON THE PERSONAL PRONOUNS.

The French, as well as the English, use the second person plural for the second person singular in addressing one person.

The second person singular, however, is used, as in English, in addressing the Supreme Being:—

Grand Dieu! tes jugements sont remplis d'équité. DES BARREAUX.	*Great God! Thy judgments are full of equity.*

It is also used in poetry, or to give more energy to the expression:—

O mon souverain roi! Me voici donc tremblante et seule devant toi. RACINE, "*Esther.*"	*O my sovereign king! Here I am, trembling and alone before thee.*

It is used by parents to children, and also among intimate friends.

The pronoun *il* is used impersonally, in the same manner as the English pronoun *it*:—

il pleut, *it rains;* *il* gèle, *it freezes.*

Observe that the personal pronouns of the third person are not used for the indirect object, in reference to inanimate objects. The relative pronouns *en*, *of* or *from it*, *y*, *to it*, are used instead of the personal pronouns. Thus, in speaking of a *house*, we do not say, *Je* lui *ajouterai une aile.* We must say:—

J'y ajouterai une aile.	*I will add a wing to it (thereto)*

In speaking of an author, we may say:—

Que pensez-vous *de lui?*	*What do you think of him?*

But in speaking of his book, we should say:—

Qu'en pensez-vous?	*What do you think of it (thereof)?*

The word *même*, plural *mêmes*, may be used after the pronoun in the sense of *self*, *selves*:—

Le roi *lui-même*,	*The king himself.*
La reine *elle-même*,	*The queen herself.*
Les princes *eux-mêmes*,	*The princes themselves.*
Les princesses *elles-mêmes*,	*The princesses themselves.*

The pronouns *moi*, *toi*, *lui*, *eux*, are often used after the verb or before the pronoun subject, for the sake of emphasis:—

Je le dis, *moi*,	*I say so, or I do say so.*
Il le dit, *lui*,	*He says so, or he does say so.*
Lui, *il* le désire autant que vous.	*As for him, he wishes it as much as you do.*

The same pronouns *moi*, *toi*, *lui*, *eux*, are used instead of the nominative pronouns *je*, *tu*, *il*, *ils*, for the English pronouns *I*, *thou*, *he*, *they*, when those pronouns have a verb understood after them, as in answer to a question or after a comparative:—

Qui est arrivé ce matin? *Moi.*	*Who arrived this morning? I.*
Vous écrivez mieux que *lui.*	*You write better than he.*
Vous lisez aussi bien que *moi.*	*You read as well as I.*

This is in complete contrast with the English usage.

The same pronouns are used in exclamatory sentences before a verb in the infinitive; before relative pronouns; before adjectives, past or present participles, and after the verb *to be* used impersonally:—

Moi, lui céder!	*I, yield to him!*
Eux, aller à Londres!	*They, go to London!*
Moi qui suis malade . . .	*I who am sick . . .*
Lui que je connais.	*He whom I know.*
Eux dont la conduite . . .	*They, whose conduct . . .*
Lui, courageux et dévoué, partit à l'instant.	*He, courageous and devoted, immediately set out.*
Lui parti, la bande se dispersa.	*He gone, the band dispersed.*
Eux, voyant qu'il était mort, s'enfuirent.	*They, seeing that he was dead, ran away.*
C'est *moi*; c'est *lui*.	*It is I; it is he.*
Ce sont *eux*.	*It is they.*

These same pronouns are also used instead of the nominatives *je*, *tu*, etc., when the verb has several subjects, whether all pronouns, or nouns and pronouns, in which case the verb may be immediately preceded by one of the pronouns *nous* and *vous*, representing in one word all the preceding subjects; *nous* being used when there is a pronoun of the first person among the subjects, and *vous* when there is a pronoun of the second and none of the first:—

Votre père et *moi*, *nous* avons été longtemps ennemis l'un de l'autre. FÉNELON.	*Your father and I were a long time enemies.*
Ton frère, et *toi*, *vous* m'avez trompé. MONTESQUIEU.	*Thy brother and thou have deceived me.*

The recapitulating pronoun and the verb sometimes come first in the sentence:—

Nous avons, *vous* et *moi*, besoin de tolérance. VOLTAIRE.	*You and I have need of tolerance.*

The same pronouns, *moi*, *toi*, *lui*, *eux*, are used instead of *je*, *tu*, *il*, *ils*, when the several subjects of various verbs have performed different actions connected together, or tending to the same end:—

Tandis qu'*ils* défendaient le pays, *lui* le gouvernait sagement.	*Whilst they were defending the country, he governed it wisely.*

The reflective pronoun *se*, *himself*, etc., is used for both genders and for both numbers; for persons and for things; and always accompanies a verb:—

Les yeux de l'amitié *se* trompent rarement. VOLTAIRE.	*The eyes of friendship are seldom deceived (deceive themselves).*

The same pronoun has sometimes a reciprocal and sometimes a reflexive meaning, according to the context:—

Ils *se* flattent,	*They flatter themselves.*
Ils *se* flattent,	*They flatter one another (each other).*

In this case, the indefinite pronoun *l'un l'autre* is placed after the verb, or the word *entre* prefixed to it for the sake of clearness:—

Ils *s'aiment l'un l'autre, or* ils *s'entr'*aiment.	*They love one another.*

Soi (*himself, itself*), etc., is of both genders and numbers, and is applied to persons and things. It is used in reference to a noun or a pronoun relating to a particular individual or object, and in general and indeterminate sentences:—

On a souvent besoin d'un plus petit que *soi.* LA FONTAINE.	*We have often need of one inferior to ourselves.*
Cet homme ne parle que de soi.	*This man only speaks of himself.*
Le vice est odieux de *soi.*	*Vice is odious in itself.*

POSSESSIVE PRONOUNS.

The possessive pronouns, which are formed from the personal pronouns, represent, in the radical part, the *possessor*, while in termination they always agree with the thing possessed. Some relate to one person, some to several.

POSSESSIVES RELATING TO ONE PERSON.

The object possessed being in the—

	Singular.		*Plural.*		
	Masc.	*Fem.*	*Masc.*	*Fem.*	
1.	le mien,	la mienne,	les miens,	les miennes,	*mine.*
2.	le tien,	la tienne,	les tiens,	les tiennes,	*thine.*
3.	le sien,	la sienne,	les siens,	les siennes,	*his, hers, its.*

POSSESSIVES RELATING TO TWO OR MORE PERSONS.

The object possessed being in the—

	Singular.		*Plural.*	
	Masc.	*Fem.*	*Masc. and Fem.*	
1.	le nôtre,	la nôtre,	les nôtres,	*ours.*
2.	le vôtre,	la vôtre,	les vôtres,	*yours.*
3.	le leur,	la leur,	les leurs,	*theirs.*

REMARKS ON THE POSSESSIVE PRONOUN.

It may be seen from the table given above that the termination of the possessive pronoun agrees in gender and number with the object possessed:—

Votre canif et *le mien.* *Your penknife and mine.*	Votre plume et *la mienne.* *Your pen and mine.*
Vos frères et *les miens.* *Your brothers and mine.*	Vos sœurs et *les miennes.* *Your sisters and mine.*

The article is an inseparable part of these pronouns, and undergoes with them the same change as when it is joined to a noun:—

of mine du mien, *de la* mienne,	*des* miens, *des* miennes, etc.
to ours au nôtre, *a la* nôtre,	*aux* nôtres, *aux* nôtres, etc.
Je parle de ses parents, et il parle *des* leurs.	*I speak of his relatives, and he speaks of theirs.*

These pronouns should relate to a noun* previously expressed, with which they *must* agree in gender, although they may differ in number:—

Votre maison est plus haute que *la leur.*	*Your house is higher than theirs is.*
Son frère est plus âgé que *les vôtres.*	*His brother is older than yours are.*

These pronouns may, however, be used absolutely when we mean thereby our family, near relatives, friends, partisans, soldiers, countrymen, etc.:—

Moi, j'ai les *miens*, la cour, le peuple à contenter. LA FONTAINE.	*I have my family or friends, the court, the people to please.*
Malheureux . . . . qui porte chez les *siens* le glaive et les flambeaux. COLARDEAU.	*Wretched is he who carries among his fellow-citizens the sword and the torches.*
C'est à nous à payer pour les crimes des *nôtres.* RACINE.	*We must bear the penalty of the crimes of our family or people.*

Le mien and *le tien* are also used absolutely as the words *mine* and *thine* in English, in the sense of possession, property:—

Et *le mien* et *le tien*, deux frères pointilleux. BOILEAU.	*And mine and thine* (meum and tuum), *two punctilious brothers.*
Le tien et *le mien*, sont les sources de toutes les divisions et de toutes les querelles. GIRAULT-DUVIVIER.	*Mine and thine* (meum and tuum) *are the sources of all divisions and quarrels.*

* This rule is not always observed in mercantile correspondence, in which is often found: **J'ai reçu** *la vôtre* **en date du** . . . instead of *J'ai reçu votre lettre en date du* . . . *I received your letter dated* . . . a form which is not to be imitated.

TRANSLATIONS FROM FRENCH.

MOLIÈRE.

Molière and Racine are the two great names connected with the drama in the reign of Louis XIV. As a comic writer, Molière can hardly be said to have an equal; his characters are types which will always live, types taken from all sorts and conditions of men, men of the court, of the town, and of the country; nobles, merchants, doctors, lawyers, bores, pedants, fops, servants, masters—men who can be recognised as of any age and of any country. Jean-Baptiste Poquelin (*Molière* was only his professional name) was born in Paris in 1622. His father was upholsterer and *valet de chambre* to the King, and until he was fourteen years old, young Poquelin could do little beyond reading and writing, as it was intended he should succeed his father in the shop. However, through his grandfather's advice, young Poquelin was sent to the Jesuits' College at Clermont, where he studied with very good effect for five years. At the end of that time he became manager of a strolling company of players who travelled in the provinces, playing farces. This gave him an opportunity of gaining experience, and of trying his hand at writing comedies. In 1658 Molière came to Paris, and through the Prince de Conti, who had been a fellow student of his at college, had an introduction to the only brother of the King Louis XIV., and by him was presented to the King and to the King's mother.

From this time his fortune was made, and Molière soon received permission to set up in Paris with his company. A hall in the Palais-Royal was granted to him, and there until his death in 1673, Molière brought out, and acted in, all his plays.

His best plays are *Le Misanthrope*, a satire on fashionable life: *Tartuffe*, a satire on religious hypocrisy; and *Les Femmes Savantes*, a satire on the "blue-stockings" of the day.

The extracts here given are from *Le Bourgeois Gentilhomme*, an amusing play, satirising the difficulties of a rich citizen, who wishes to rise in the social scale, and to this end is trying to arrange the marriage of his daughter with a marquis.

M. Jourdain (à Nicole, la servante). Taisez-vous, impertinente; vous vous fourrez toujours dans la conversation. J'ai du bien assez pour ma fille; je n'ai besoin que d'honneurs, et je veux la faire marquise.

Madame Jourdain.—Marquise?

M. Jourdain.—Oui, Marquise.

Madame Jourdain.—Hélas! Dieu m'en garde!

M. Jourdain.—C'est une chose que j'ai résolue.

Madame Jourdain.—C'est une chose, moi, où je ne consentirai point. Les alliances avec plus grand que soi sont sujettes toujours à de fâcheux inconvénients. Je ne veux point qu'un gendre puisse reprocher à ma fille ses parents, et qu'elle ait des enfants qui aient honte de m'appeler leur grand'maman. S'il fallait qu'elle me vint visiter en équipage de grande dame, et qu'elle manquât par mégarde à saluer quelqu'un du quartier, on ne manquerait pas aussitôt de dire cent sottises. "Voyez-vous," dirait-un, "cette madame la marquise qui fait tant la glorieuse? C'est la fille de M. Jourdain qui était trop heureuse, étant petite, de jouer à la madame avec nous. Elle n'a pas toujours été si relevée que la voilà, et ses deux grands-pères vendaient du drap auprès de la Porte-Saint-Innocent. Ils ont amassé du bien à leurs enfants, qu'ils payent maintenant peut-être bien cher en l'autre monde; et l'on ne devient guère si riche à être honnêtes gens." Je ne veux point tous ces caquets, et je veux un homme, en un mot, qui m'ait obligation de ma fille, et à qui je puisse dire: "Mettez-vous là, mon gendre, et dinez avec moi."

M. Jourdain.—Voilà bien les sentiments d'un petit esprit, de vouloir demeurer toujours dans la bassesse. Ne me répliquez pas davantage; ma fille sera marquise, en dépit de tout le monde, et si vous me mettez en colère, je la ferai duchesse.

ACTE III., SCÈNE XII. "LE BOURGEOIS GENTILHOMME."

KEY TO TRANSLATIONS (p. 109).

PASCAL'S "PENSÉES."

If we were to dream every night the same thing, it would affect us, perhaps, as much as the objects which we see every day. And if a workman were sure of dreaming every night for twelve hours that he was a king, I believe that he would be nearly as happy as a king who dreamt every night for twelve hours that he was a workman. If we were to dream every night that we were followed by enemies and disturbed by painful phantoms, and that we were to pass every day in different occupations—for instance, in going on a journey, we should suffer nearly as much as if it were true; and we should dread to sleep, just as we dread the waking, when we fear actually to encounter such misfortunes. In fact, these dreams would cause nearly the same evils as the reality. But because dreams are all different and varied, what we see in them affects us much less than what we see in waking, because of the continuity, which is not, moreover, so continuous and equal that it does not also change, but less abruptly, (even) if it is less often, as in travelling; and then we say, "It seems to me as if I am dreaming;" for life is a dream a little less changeable.

THE THINKING REED.

Man is only a reed, the weakest in nature; but he is a thinking reed. It is unnecessary that the whole Universe should arm itself to crush him. A vapour, a drop of water, suffices to kill him. But if the Universe should have crushed him, man would still be nobler than that which slays him, because he knows that he is dying, and the Universe knows nothing of the advantage it has over him.

BOOK-KEEPING.—XIII.

[*Continued from p. 114.*]

THE LEDGER (*continued*).

Dr. TOBACCO GOODS. Cr. (12)

1898.			£	s.	d.	1898.			£	s.	d.
Feb. 28	To Sundries	371	95	15	9	Feb. 28	By Sundries	371	76	16	4
Mch. 31	„ do.	62	558	15	–	Mch. 31	„ do.	62	23	9	2
May 31	„ do.	63	15	3	8	Ap. 30	„ do.	62	52	10	11
June 30	„ Profit and Loss	63	23	2	9	May 31	„ do.	63	60	–	10
						Jun. 30	„ do.	63	21	15	–
						„ „	„ Balance	64	445	4	11
			692	17	2				692	17	2
July 1	To Balance		445	4	11						

The preceding four accounts are Goods accounts. Collectively they constitute the ordinary Goods account of the Business. As explained in lesson VI., p. 94, Vol. III., they might be actually combined in one account if the ruling of the account were duly prepared, *i.e.*, if four sets of money columns were ruled on the debit side of the account, and four on the credit. The first debit and credit set would then contain Drapery items, the second Tea, and so on. This combination of separate Goods accounts into one general account for Goods, is rendered more perfect by adding another set of columns to each side of the account, for the insertion of the horizontal totals.

GOODS ON COMMISSION.

Dr. STEPHEN WHITE, NEWCASTLE-ON-TYNE. Cr. (13)

			£	s.	d.				£	s.	d.
1898.						1898.					
Mch. 31	To Commission	62	10	6	-	Jan. 31	By Sundries	370	46	10	-
Ap. 30	,, Cash	62	20	5	-	Feb. 28	,, do.	371	56	10	-
May 31	,, do.	63	41	3	6	Jun. 30	,, do.	63	86	5	-
Jun. 30	,, do.	63	31	5	6						
,, ,,	,, Commission	63	8	12	6						
,, ,,	,, Balance	64	77	12	6						
			189	5	-				189	5	-
						July 1	By Balance		77	12	6

An account for Goods sold by the Business on Commission is an Agency account. If a particular Agency embraces either frequent or large transactions, it is better to keep a special account for it, as above; if, however, there exist a number of agencies of a temporary kind, embracing only one or two transactions, and those of comparatively small amounts, a collective account is sufficient, details of this collective account being kept in a book provided for the purpose.

In numerous cases of Goods received for Sale on Commission, the Invoice price is debited to the account for "Goods on Commission," and credited to the Sender's account; and when the Goods are sold, the selling price is credited to "Goods on Commission," and debited to the Purchaser's account. Finally, the Sender's account is charged with Commission on Goods sold and the "Commission" account credited. In this arrangement any excess received over Invoice price is considered to be profit to the Business, and is carried off to Profit and Loss, like the profit on any other class of Goods. The Sender's account is ultimately closed for Goods sold, by payment to him of the balance due. The student should be reminded that any Goods on Commission unsold at the date of making up the Balance Sheet of the Business should appear neither as an Asset nor as involving a Liability to the Owner of the Goods. Such Goods remain the property of the Owner until actually sold, and do not really affect the Liabilities and Assets of the Business, for they do not at any moment belong to it.

Dr. SUSPENSE. Cr. (14)

			£	s.	d.				£	s.	d.
1898.						1898.					
June 30	To Profit and Loss	63	5	-	-	Feb. 28	By Cash	371	5	-	-

Receipts and payments or charges, the final appropriation of which is not at the time known, are placed in "Suspense" pending further information. The finding of money which may be reclaimed, and the payment of money into court to await a judicial decision, or the mere reservation of money for such a purpose, are simple instances of items for which a Suspense account is required. The personal accounts now to follow, whether accounts for merchants or customers, need no explanation beyond what has gone before. As in the case of nominal accounts, the balances at the close of the accounts are always brought down by journal entries (not shown) on the 1st July.

Dr. SAMUEL PERKINS, London. Cr. (15)

1898.			£	s.	d.	1898.			£	s.	d.
Feb. 2	To Bill Pble. (due May 5)	311	1,358	15	–	Jan. 2	By Drapery Goods	92	1,358	15	–
Mch. 29	" do. (July 2)	311	513	10	–	Mch. 1	" do.	93	513	10	–
May 31	" Discount - -	236	7	15	2	May 1	" do.	93	310	8	4
" "	" Cash - - -	236	302	13	2	June 1	" do.	93	185	12	11
June 30	" Balance - -	64	185	12	11						
			2,368	6	3				2,368	6	3
						July 1	By Balance - -		185	12	11

Dr. GEORGE GREENFELL, Poole. Cr. (16)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 3	To Drapery Goods -	171	284	19	8	Jan. 4	By Discount -	234	11	8	–
Mch. 4	" do. -	172	94	–	11	" "	" Cash - -	231	273	11	8
						Mch. 4	" do. - - -	235	50	–	–
						June 1	" do. - - -	236	22	–	6
							" Bad Debts -	63	22	–	5
			379	–	7				379	–	7

Dr. JOHN LOADER, Rugby. Cr. (17)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 4	To Drapery Goods -	171	416	13	4	Jan. 5	By Discount - -	234	14	11	8
Feb. 1	" do. -	171	208	17	1	" "	" Cash - - -	231	402	1	8
Ap. 1	" do. -	173	95	9	1	Ap. 2	" Bills Rec. (3 Mos.), £[illegible]; 5 Jun., £100; 5 July, £100	311	203	18	10
June 2	" do. -	174	78	16	11	" "	" J. Loader (return.)	62	–	7	4
						" 15	" Drapery Goods "	173	1	–	10
						June 30	" Balance - -	61	77	16	1
			799	16	5				799	16	5
July 1	To Balance - - -		77	16	1						

Dr. RICHARD LARKING, Bolton-le-Moors. Cr. (18)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 10	To Drapery Goods -	171	163	6	6	Jan. 11	By Discount - -	231	5	14	4
Feb. 2	" do. -	171	135	16	2	" "	" Cash - - -	231	157	12	2
Mch. 4	" do. -	172	92	1	7	Feb. 4	" Discount - -	311	3[illegible]	7	11
" 7	" Cash (bill dishnd.)	235	132	9	9	" "	" Bill Rec. (7 Mch.)	311	132	8	3
						Mch. 5	" Cash - - -	235	74	11	4
						" 15	" do. - - -	235	30	–	–
						" 22	" do. - - -	235	30	–	–
	Carried to p. 19 -		523	14	–		Carried to p. 19		488	14	–

Dr. RICHARD LARKING, Bolton-le-Moors. **Cr.** (19)

			£	s.	d.				£	s.	d.
1898.	Brought from p. 18		523	14	–	1898.	Brought from p. 18		433	14	–
						Mch. 29	By Cash	235	30	–	–
						Ap. 5	,, do.	235	30	–	–
						,, 12	,, do.	235	30	–	–
			523	14	–				523	14	–

Dr. WORMELL & Co., London. **Cr.** (20)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 9	To Bills Pable. (12 Feb.)	311	638	–	5	Jan. 9	By Tea	92	638	–	5
Ap. 3	,, do. (6 May)	311	183	6	3	Ap. 1	,, do.	93	183	6	3
May 4	,, do. (7 June)	311	104	18	4	May 2	,, do.	93	104	18	4
			926	5	–				926	5	–

Dr. GEORGE CRISFORD, Bridport. **Cr.** (21)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 10	To Tea	171	117	16	10	Jan. 12	By Discount	234	4	6	6
Ap. 2	,, do.	173	78	14	–	,, ,,	,, Cash	234	113	10	4
May 1	,, do.	173	187	13	9	Ap. 4	,, Discount	235	2	16	9
						,, ,,	,, Cash	235	75	17	3
						May 3	,, Hy. Humphreys (correction)	63	187	13	9
			384	4	7				384	4	7

Dr. HENRY HUMPHREYS, Reading. **Cr.** (22)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 10	To Tea	171	32	9	4	Jan. 14	By Discount	234	1	4	6
May 3	,, Geo. Crisford (corn. Tea sold on 1 May)	63	187	13	9	,, ,,	,, Cash	234	31	4	10
						May 3	,, Discount	236	6	17	2
							,, Cash	236	180	16	7
			220	3	1				220	3	1

Dr. THOMAS CANTON, Truro. **Cr.** (23)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 17	To Tea	171	19	18	4	Jan. 18	By Bill Rec. (Mch. 20)	311	19	18	4
Mch. 5	,, do.	172	30	16	–	Mch. 8	,, do. (June 11)	311	30	16	–
			50	14	4				50	14	4

Dr. JOHN AMERY, HIGHGATE. Cr. (24)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 18	To Tea	171	13	18	4	Jan. 18	By Cash	234	13	18	4
Feb. 4	" do.	171	24	13	-	Feb. 4	" do.	234	24	13	-
May 2	" do.	173	25	14	10	May 9	" do.	236	25	14	10
			64	6	2				64	6	2

Dr. PRALL & SON, NORTHAMPTON. Cr. (25)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 18	To Discount	234	10	19	7	Jan. 17	By Boots and Shoes	92	219	12	-
	" Cash	234	208	12	5	Feb. 4	" do.	92	118	16	-
Mch. 4	" Bill Payable (7 Jun.)	311	118	16	-	Ap. 4	" do.	93	123	6	-
May 2	" do. (3 Aug.)	311	123	6	-	Jun. 5	" do.	93	110	18	6
Jun. 30	" Balance	64	110	18	6						
			572	12	6				572	12	6
						July 1	By Balance		110	18	6

Dr. WALTER RUSSELL, MAIDSTONE. Cr. (26)

1898.			£	s.	d.	1898.			£	s.	d.
Feb. 6	To Boots and Shoes	172	23	14	-	Mch. 8	By Discount	235	-	11	10
Ap. 5	" do.	173	20	14	-		" Cash	235	23	2	2
Jun. 6	" do.	174	14	5	-	May 3	" Discount	236	-	10	4
							" Cash	236	20	3	8
						Jun. 30	" Balance	64	14	5	-
			58	13	-				58	13	-
July 1	To Balance		14	5	-						

Dr. GEORGE GREEN, BRIGHTON. Cr. (27)

1898.			£	s.	d.	1898.			£	s.	d.
Mch. 7	To Boots and Shoes	173	19	1	-	Ap. 6	By Bill Rec. (7 July)	311	19	1	-
May 14	" do.	173	7	1	9	Jun. 8	" do. (4 Sept.)	311	7	1	9
			26	2	9				26	2	9

Dr. CHARLES CHAMBERS, BIRMINGHAM. Cr. (28)

1898			£	s.	d.	1898.			£	s.	d.
Feb. 8	To Boots and Shoes	172	16	10	-	Mch. 9	By Discount	235	-	8	3
Mch. 21	" do.	173	11	15	6		" Cash	235	16	1	9
May 17	" do.	174	11	6	6	Ap. 20	" Bill Rec. (21 July)	311	11	15	6
						Jun. 15	" do. (17 Sept.)	311	11	6	6
			39	12	-				39	12	-

BOTANY.—XI.

[*Continued from p. 119.*]

THE GYNÆCEUM (*continued*).

In describing the gynæceum we will consider the ovary, style, stigma, and ovules separately. After discovering the number of carpels and noting whether they are apocarpous or syncarpous, we have to observe with reference to the ovary (i.) its adhesion or position in relation to the "calyx-tube"; (ii.) its general form; (iii.) the number of chambers in it; (iv.) the number and position of the ovules in each chamber; and (v.) the placentation.

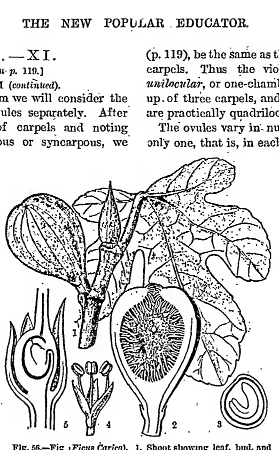


Fig. 56.—Fig (*Ficus Carica*). 1. Shoot showing leaf, bud, and infrutescence. 2. Infrutescence in section. 3. Fruit, with albuminous seed. 4. Male flower. 5. Female flower in section, showing campylotropous ovule.

The ovary is termed *superior* with reference to the calyx, not necessarily when it is at a higher level, but when it is not adherent to the calyx, as in all hypogynous and some perigynous flowers, the buttercup, rose, primrose, or tulip, for example. Similarly it is termed *inferior* when it is adherent to the "calyx-tube," when it is often visible as a swelling below the flower, as in cucumber, orchids, *Narcissus*, *Iris*, etc., and all epigynous flowers. A study of floral development in these cases, as in the *Compositæ*, often shows that the cavity of the ovary is mainly formed by a tubular intercalary growth of the receptacle carrying up the superior sepals and epigynous petals and stamens and merely arched over by the carpels. An intermediate condition occurs in saxifrages, where the adhesion only extends half way up the side of the ovary, which is then termed *half-superior;* and in *Pomaceæ* (apples, pears, hawthorn, medlar, etc.), where there is no adhesion in the flower stage but the carpels become subsequently imbedded in the pulpy receptacular tube which carries up the sepals and forms the bulk of the fruit. The general form of the ovary as seen from the outside may be *spherical, conical, lobed, cylindric*, &c., terms which explain themselves; and the number of chambers in it, as seen in a syncarpous form from a transverse section need not, as we have seen (p. 119), be the same as the number of its component carpels. Thus the violet and mignonette have *unilocular*, or one-chambered, ovaries, though made up of three carpels, and *Boraginaceæ* and *Labiatæ* are practically quadrilocular although bicarpellary.

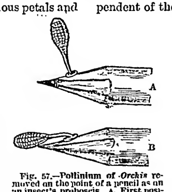


Fig. 57.—Pollinium of *Orchis* removed on the point of a pencil as on an insect's proboscis. A. First position. B. Position assumed after a short interval.

The ovules vary in number from being *solitary*, only one, that is, in each chamber (or in the whole ovary), as in *Compositæ*, *Ranunculaceæ*, *Umbelliferæ*, or *Gramineæ*, or two, as in *Drupaceæ* or *Cupuliferæ*, up to an indefinite number, as in poppies, violets, foxgloves, etc. In position they may be *erect*, rising, that is, from the base of the ovary, as in *Compositæ*, *Polygonaceæ*, &c.; *ascending*, or attached at the side of the ovary near the base and sloping upward; *horizontal*, as in *Cruciferæ*; or *suspended*, as in *Umbelliferæ*, and in the Fig. (Fig. 56, *5*. Different ovules in the same ovary sometimes occur in different positions. Apart from individual position the ovules spring in various ways from special regions of the wall of the ovarian cavity. These regions are often made up of soft spongy tissue, and are termed *placentas*, and the arrangement of the ovules is therefore called their *placentation*. In a few cases a single ovule, or a placenta bearing several ovules, appears to be a direct prolongation of the floral axis, independent of the carpellary leaves which may form an ovary round it. This is termed *axial placentation*. Thus in the yew (*Taxus*) an ovule terminates a branch and no carpel is formed. In the superior ovaries of the Reed-mace, now often called the Bulrush (*Typha*), of the rhubarb tribe (*Polygonaceæ*), and of the peppers (*Piperaceæ*) the solitary erect ovule appears to be *terminal*, or a direct prolongation of the axis, that is, a stem-structure, and the same may be true in the inferior ovary of the walnut (*Juglandeæ*). In the *Compositæ* one ovule arises from the base of the inferior ovary, but it is *lateral* to the axis, the apex of which is visible beside it, so that the ovule is a lateral appendage corresponding (homologous) to a leaf. So too in

INFLORESCENCES.

1 Umbel of Ivy; 2, Raceme of Wild Hyacinth; 3, Catkin of Hazel; 4, Corymbose raceme of Wallflower; 5, Dichasial cyme of Pink; 6, Head of Daisy; 7, Panicle of Horse Chestnut; 8, Spike of Plantain;

Primulaceæ the placenta is a prolongation of the axis and bears lateral ovules. In a few other cases, as in water-lilies, poppies, and *Butomus*, the ovules are produced all over the inner surface of the carpellary leaves. They are then termed *superficial*, and are generally somewhat rudimentary in structure, being probably homologous to trichomes. In the majority of flowering plants the ovules are *marginal*, corresponding to leaflets of the carpellary leaf, as is sometimes seen in cases of abnormal development. In most one-chambered ovaries the margins of the carpellary leaves form the spongy placentas and bear the ovules, often in double rows, each row belonging to one leaf-margin. This is termed *parietal placentation*. In *Cruciferæ* we have the exceptional case of parietal placentation in a two-chambered ovary, the margins of the two carpellary leaves splitting and one half growing inwards so as to form the partition, or *replum*, while the other half bears the ovules. Multilocular ovaries are so mainly from the infolding of the margins of the carpellary leaves which form the *septa* or *dissepimenta* between the loculi or chambers. In poppies and cucumbers this infolding is only partial; but in lilies, *Iris*, and other instances these septa unite to form a *central* placenta from which the ovules project outward. This central placentation has been termed "axile." In the *Caryophyllaceæ* the septa connecting the central placenta with the side walls of the ovary can only be detected at its base, and that only in the young state, except in the pinks (*Dianthus*), for which reason this placentation, resembling that of *Primulaceæ*, has been termed *free central*.

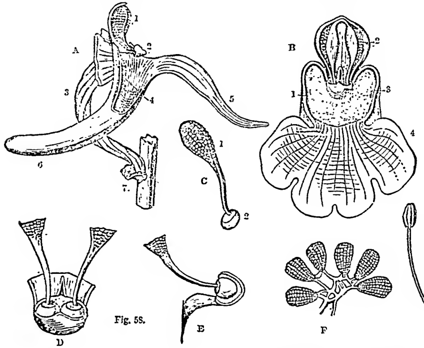


Fig. 58.

Fig. 59.

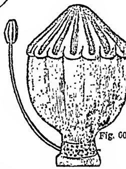


Fig. 60.

Fig. 58.—*Orchis mascula*. A. In partial section, perianth mostly removed: 1. Anther; 2. Bursicle; 3. Twisted inferior ovary; 4. Stigma; 5. Labellum; 6. Spur; 7. Bract cut off. B. Front view: 1. Stigma; 2. Pollinium; 3. Bursicle; 4. Labellum. C. 1. Pollinium; 2. Retinaculum. D. Bursicle, drawn forward showing the retinacula. E. The same in lateral section. F. Pollen massulæ with connecting threads.

Fig. 59.—Berry of the Gooseberry (*Ribes Grossularia*) in section, showing the persistent calyx, parietal placentation, and anatropous ovules.

Fig. 60.—Gynæceum and one stamen of Poppy, showing radiate stigma and hypogynous insertion.

The *style* may be absent, when the stigma is sessile on the top of the ovary, as in the poppies (Fig. 60); or, if present, it may vary considerably in form or position. Even when there are several united carpels forming distinct chambers to the ovary, as in lilies, there may be only one style; or they may be as many as the carpels, as in grasses; or there may be one below, dividing above, as in *Iris* and the *Compositæ*. The style generally rises from the apex of the ovary (*terminal*); but sometimes, from the ovary growing faster, it appears *lateral*, as in the strawberry, or even *basilar*, as in *Alchemilla*. In *Labiatæ* and *Boraginaceæ* the united styles of

the four-chambered ovary arising laterally in this manner seem to spring from a depression in the centre of an ovarian ring, and are called *gynobasic.* The styles may be *erect* or *spreading*; *glabrous* or *hairy*; *cylindric* or *grooved.* Though generally rod-like, they may be *petaloid*, as in the upper portion of those of *Iris* and *Crocus.* In primroses, *Linum perenne*, *Lythrum*, and *Oxalis*, the flowers are *heterogonous*, or hetero-styled, different individuals of the same species bearing flowers with styles of two different lengths (*dimorphic*) in the first two cases, and of three different lengths (*trimorphic*) in the last two. Darwin showed this to be an adaptation for cross-pollination, the pollen from any stamen being *prepotent*, germinating, that is, sooner and more efficaciously, upon the stigma of a style of the same length, which only occurs in a distinct flower. Obviously the same part of an insect's body will come in contact with any anther and with the stigma of a style of the same length as the stamen, thus suitably cross-pollinating the two flowers. In the primrose there is only one whorl of stamens, which in the *long-styled* or *pin-eyed* form are half-way down the corolla-tube, in the *short-styled* or thrum-eyed form project, like the thrum in weaving, at the throat or "eye" of the flower. So too in the flax (*Linum perenne*), the anthers of the five stamens of the long-styled form are on a level with the stigmas in the short-styled form, and *vice-versâ.* In *Lythrum* and *Oxalis* the stamens are in two whorls of different lengths, and the styles in any one form are a different length from either whorl, being either *long-styled*, *medium-styled*, or *short-styled.* The styles may be either *deciduous*, withering or being absorbed after fertilisation, as in the plum, or may be *persistent*, as in the strawberry and blackberry.

The *stigma* consists of a surface of cellular papillæ covering the mouth of the *stylar canal*, or tubular passage leading into the ovarian cavity, and, when mature, excreting a sugary solution. It may be *linear*, as in the curved line below the bifurcation of the petaloid portion of the style in *Iris*, in the line on the inner surfaces of the Y-shaped style of *Compositæ*, or in the sessile radiating lines on the ovaries of poppies (Fig. 60) and water-lilies. In grasses and other wind-fertilised flowers the stigmatic surface is distributed over a *feathery* or *plumose* branching of the style; in lilies and many other cases the stigmatic surface is *lobed*, the lobes corresponding in number to the carpels; and in other instances as in primroses, it is simply rounded, hemispherical, globular, or *capitate.*

In *Viola* and *Butomus* the stylar canal is a hollow tube; but in most cases it is filled by loosely-arranged cells forming the *conducting tissue*, which is continuous with the placentas, or may fill the upper part of the ovary, or be continued in lines down the inside of it.

The *ovule*, or unfertilised seed, originates as a papilla of parenchymatous cells; or, in orchids, in a single cell of the placenta. In this latter group the ovules have actually not made their appearance when the pollen falls upon the stigma. Their simple structure in this case and when they are superficial suggests, as we have seen, that they are homologous to trichomes, whilst ordinary marginal ones are homologous to leaflets, the lateral ones of *Compositæ* and *Primulaceæ*, to leaves, and the terminal ones of *Taxus*, *Polygonaceæ*, &c., or at least their central portion, or *tercine*, to the apex of a stem. The conical papilla, known as the *tercine*, or *nucellus*, or objectionably as the "nucleus," soon becomes elongated into an oval body, generally raised on a stalk or *funicle*; and from its base, from the apex, that is, of the funicle, a coat, or more generally two successive coats, originate as circular ridges and grow up over the tercine. The inner, first-formed, coat is termed the *secundine*; the outer, the *primine.* These coats do not completely close over the tercine, but leave an opening at the apex termed the *micropyle* (Greek μικρός, *mikrŏs*, little; πύλη, *pulē*, a door). The base of the tercine, where the two coats (the secundine and primine) arise, is called the *chalaza*, and, except in superficial and other rudimentary ovules, it contains the termination of a bundle of spiral vessels, which come from the placenta and traverse the funicle. The external point of junction between the funicle and the body of the ovule, marked, when the ripe seed becomes detached, by a scar, is the *hilum.* If the ovule and its tercine are straight, *i.e.*, neither inverted nor bent upon themselves, as in the *Polygonaceæ*, the ovule is *atropous* or *orthotropous* (Greek, ἀ, *a*, not; ὀρθὸς, *ŏrthŏs*, straight; τρέπω, *trĕpō*, I turn). In this case the funicle is generally short; the chalaza and hilum will be near together at the base, and the micropyle at the apex of the ovule; and the ovule will commonly be solitary and erect, so that the micropyle is directly under the base of the stylar canal, the upper part of the ovary being filled with conducting tissue. More commonly, as in *Compositæ*, *Leguminosæ*, *Umbelliferæ*, *Cupuliferæ*, *Liliaceæ*, etc., the ovule is inverted, or *anatropous* (Greek, ἀνὰ, *ana-*, back), owing to the rapid growth of the funicle and its adhesion to the primine, so that the chalaza is carried up to the apex of the ovule and the micropyle brought down close to the placenta, though the tercine remains straight (Fig. 59). The adherent funicle is termed the *raphe* (Greek, ῥαφὴ, *raphē*, a seam). It is clearly seen as a brown thread

down one side of the kernel of a hazel-nut. By this arrangement the pollen-tubes in a large ovary not filled with conducting tissue are able to grow down the spongy placentas and enter the micropyles without traversing much empty space. The same result is also, but less commonly, brought about, as in *Cruciferæ*, *Malvaceæ*, etc., by the ovule becoming *campylotropous* (Greek, καμπυλος, *kampulŏs*, curved) or bent upon itself, when the funicle remains short and the chalaza at the base near the hilum, as in the atropous case, but the micropyle is brought down near the base, so as externally to resemble the anatropous condition, by a bending of all the ovule upon itself, like a horse-shoe.

At the time when the flower opens there is in angiosperms one cell just below the apex of the tercine, separated from the bottom of the micropyle by one or two layers of cells, which is larger than the surrounding cells. This is the megaspore or *embryo-sac*, so-called because within it the embryo, or seedling plant, is formed. Before fertilisation the nucleus of the embryo-sac (*primary nucleus of the embryo-sac*) divides into two daughter-nuclei, which travel to opposite ends of the embryo-sac, a large central vacuole being formed. Each daughter-nucleus then divides twice, so as to give rise to four *polar nuclei* at each end of the embryo-sac. One nucleus from each group of four next returns towards the centre, and the two coalesce to form the *secondary* (so-called "permanent") *nucleus* of the embryo-sac. The three remaining at each end then become invested with protoplasm, being thus primordial cells. The three at the lower or chalazan pole sometimes even acquire a cellulose wall. They are termed the *antipodal cells* or *archisperm*, and take no part in the after processes, and are eventually absorbed, being probably only the vestigial representatives of the female prothallus in the ancestral type, as will be explained in a future lesson. The three primordial cells at the upper or micropylar pole are termed the *egg-apparatus*, the two upper ones being called *synergidæ* ("helpers") and the lower one the *oosphere* ("egg-cell").

When the pollen-grain has been conveyed—whether by wind, insects, or other agency—on to the stigma, it germinates, being nourished, like a parasite, by the stigmatic secretion. One or more pollen-tubes being put out, worm their way through the conducting tissue of the stylar canal and along the placenta, sometimes even piercing cells; and still nourished by the tissue they pass through, until they enter the micropyle and in most cases have to penetrate the layer or two of cells over the embryo-sac. As has been said, pollination, or the falling of pollen on to the stigma, commonly precedes fertilisation, or the contact of the pollen-tube with the embryo-sac, by some hours. The number of tubes entering an ovary is generally larger than that of the ovules. The embryo-sac is sometimes pierced either by its own synergidæ or by the pollen-tube; but, though the reproductive nucleus at least in the latter appears to be dissolved, there is no evidence that the tube is itself perforated. Some fertilising substance, however, passes out of the tube, apparently into one of the synergidæ which loses its nucleus, and a second nucleus (*sperm-nucleus*) appears in the oosphere, which may be the reproductive nucleus of the pollen-tube. The two nuclei in the oosphere coalesce and that body at once acquires a cellulose wall, being known thenceforth as the *oospore* ("oosperm" of some authors). The synergidæ are subsequently absorbed.

The withering of the perianth and rapid enlargement of the ovary and ovules begin when the pollen germinates on the stigma, and in some orchids it is not until then that the ovules appear upon the placenta.

The oospore attaches itself inside the upper (micropylar) end of the embryo-sac, and after a time elongates and divides once or twice transversely, *i.e.*, at right angles to the long axis of the embryo-sac. Of the resulting cells, or *pro-embryo*, the two farthest from the micropyle usually form the *embryo*, or young plant, the others forming a suspending cord or *suspensor*. Subsequent divisions cause this suspensor to consist of a chain of a variable number of cells. The terminal or *embryo-cell* becomes usually globular, and is divided first into octants by three walls at right angles to one another, and then by periclinal walls—walls, that is, parallel to the surface of the sphere—an outer layer of cells is separated. This is the *dermatogen*, or primary epidermis of the embryo. The inner mass then undergoes further divisions and other tissue systems become differentiated. In the centre a group of cells elongate and form the *plerome*, from which the fascicular and medullary systems arise, the primary meristem between this and the dermatogen being the *periblem* or primary cortical tissue. The apical portion of the embryo, that farthest from the suspensor, gives rise to the *cotyledons*, soon making the whole embryo in dicotyledons cordate; whilst at its other extremity the *radicle* or primary root is partly formed by the *hypophysis* or penultimate cell of the suspensor. The *calyptrogen* or primary root-cap is, however, part of the dermatogen.

While the embryo is developing, other changes are in progress within the embryo-sac. The secondary nucleus of the embryo-sac divides repeatedly and forms a tissue of cells which acquire cellulose walls and are known as *endosperm* or *metasperm*. In

some very large embryo-sacs a central cavity filled with liquid, the "milk" in the cocoa-nut, remains. The endosperm forms a nutritive layer of reserve nutrition for the embryo, as do also the adjacent cells of the tercine, which, being outside the embryo-sac, are called *perisperm*. Collectively the endosperm and perisperm are called *albumen*, since they serve a physiological purpose similar to that of the "white" of an egg, the embryo corresponding to the yolk. As the embryo grows it may absorb either or both of these tissues. If either remain, a ripe seed is termed *albuminous*; but if not, *exalbuminous*. In texture the albumen varies from the hard vegetable ivory (*Phytelephas*), the *horny* consistence of coffee, in which it forms the edible portion, and the firm flesh, which is *mucilaginous* in the mallow and oily in cocoa-nut and poppies, to the *mealy* or *farinaceous* consistence in corn. In *Castalia*, *Piper*, *Canna*, and some other genera both endosperm and perisperm remain, separated by a recognisable persistent embryo-sac, in the ripe seed.

Changes also occur after fertilisation in the coats of the ovule. The primine and secundine commonly unite to form the hard tough outer coat or *testa* of the ripe seed; a more delicate creamy-white coat, the *tegmen* or *endopleura*, being formed either from the secundine, its inner portion, or the outer layer of the tercine. No rule can, however, be laid down as to the homologies of these coats. In the ivy, to a slight extent, and far more in the areca-nut and in nutmegs, the dark inner coat is so infolded as to give a marbled or *ruminate* appearance to the albumen.

Many seeds after fertilisation acquire fleshy appendages or partial investments, which grow from the testa at either the micropylar or chalazal end, or from the funicle. These are termed *arils* (Latin, *arillus*). The scarlet "Mace" round the nutmeg, or the similarly-coloured covering to the four seeds in the rose-coloured capsule of the spindle-tree that made Tennyson speak of it as "The fruit that in our autumn woodlands looks a flower," are familiar examples of arils.

GERMAN.—XXI.

[*Continued from p. 125.*]

PASSIVE VERBS IN THE INDICATIVE.

THE passive is formed by placing the auxiliary werden (to become, to be) before the past participle of the main verb. In the perfect, pluperfect, and second future tenses, the participle of werden rejects the augment ge, and is to be rendered by "been," as:—Er ist geliebt worden (not geworden), he has *been* loved. The verb sein is also used in these tenses, but with the signification of "have," as:—Er ist geliebt worden, he *has* been loved; Er war gelobt worden, he *had* been praised; Er wird gelobt worden sein he will *have* been praised.

Many intransitive verbs are used impersonally in the passive, as:—Es wurde bis spät in die Nacht gefochten, the fighting (it was fought, etc.) was continued till late in the night; Es wurde ihm von allen Seiten zu Hülfe geeilt, from all sides it was hastened to his assistance; Es wird in dem Garten von den Kindern gespielt, it is played by the children in the garden; Es wurden in dem Concert einige schöne Lieder gesungen, there (it) were sung some beautiful songs in the concert.

EXAMPLES.

Viele Menschen werden ihres Reichthums, nicht ihrer Verdien'ste wegen geach'tet.	Many persons are honoured on account of their riches, not on account of their merits.
Am Ende der Schlacht wurden die Tap'fersten mit Lorbeer bekränzt'.	At the end of the battle the most valiant were crowned with laurels.
Das Buch des Schicksals ist von Gottes Hand verschlos'sen worden, und kein Sterb'licher vermag' einen Blick in seine geheim'nißvollen Blätter zu thun.	The book of fate has been closed by the hand of God, and no mortal is able to cast a look upon (into) its mysterious pages (leaves).
Dem reichen Crösus war von dem Ora'kel das Ende seiner Herr'lichkeit verkün'digt worden.	To the rich Crœsus the end of his splendour had been announced by the oracle.
So lange Zwietracht und Wi'derspruch unter den Menschen herrscht, so lange werden die wichtigsten Wahr'heiten bekämpft' werden.	So long as discord and contradiction reign among mankind, so long will the most weighty truths be contested.
Ruhe und Friede werden erst dann in diese Thäler zurück'kehren, wenn der Feind gänzlich geschla'gen worden sein wird.	Repose and peace will first return to these valleys when the enemy shall have been utterly defeated.

VOCABULARY.

Al'penlied, *n.* song of the Alps.
An'erkennen, to acknowledge, own.
Au'genblick, *m.* moment, twinkling of an eye.
Aus'machen, to find out, ascertain.
Brief'träger, *m.* letter-carrier, postman.
Componi'ren, to compose.
Dereinst', once, one day, in the future.
Erbit'terung, *f.* exasperation, animosity.
Erken'nen, to perceive, recognise.
Erklet'tern, to climb, scramble up.
Ermor'den, to murder.
Ernst, earnest.
Gem'senjäger, *m.* chamois-hunter.

Heidnisch, heathenish, heathen, pagan.	Mit'wirkung, *f.* co-operation.	Un'benützt, not used, not availed of.
Je nachdem', as, according as.	Priester, *m.* priest.	Unschuld, *f.* innocence.
Kostbar, costly, expensive.	Schlagen, to beat, strike.	Verach'ten, to despise.
Nach'lässig, neglectful.	Schmücken, to adorn, attire.	Zeugniß, *n.* testimony.
	Tadeln, to blame, cast a blame upon one.	

EXERCISE 126.

Translate into English:—

1. Der fleißige Schüler wird von dem Lehrer geliebt und gelobt. 2. Nicht nur Wölfe und Bären, sondern auch Vögel werden von dem Jäger geschossen. 3. Der Sohn wurde von der Mutter gewarnt. 4. Der Brief wurde von dem Briefträger gebracht. 5. Das Pferd des armen Mannes ist von dem Juden gekauft worden. 6. Die Alpenlieder sind von dem Schweizer schön gesungen worden. 7. Das Buch ist von dem Kinde vergessen worden. 8. Das Kalb ist von dem Metzger geschlachtet worden. 9. Die Soldaten werden von ihrem Feldherrn gelobt werden. 10. Das Gute wird von Gott belohnt werden. 11. Dem Freunde wird von dem Nachbar geholfen worden sein. 12. Das arme Märchen wird von dem heidnischen Priester geopfert worden sein. 13. Cäsar ist unter Mitwirkung seines Freundes Brutus ermordet worden. 14. Die Steilsten Felsen werden von den Gemsenjägern erklettert. 15. Der günstige Augenblick wird von dem Klugen ergriffen. 16. Es wurde in einer halben Stunde mehr gethan, als sonst in einer ganzen. 17. Der Streit wurde auf beiden Seiten mit großer Erbitterung geführt. 18. Schon manche kostbare Stunde ist unbenützt geblieben. 19. Das Werk ist endlich vollendet worden, und wird in den ersten Tagen erscheinen. 20. Endlich ist es ausgemacht worden, wer der Dieb ist.

EXERCISE 127.

Translate into German:—

1. The son was warned by the mother. 2. Rome was founded by Romulns. 3. It was burnt by the Gauls. 4. This song was composed by Mr. G., and was sung by Mr. N. 5. Skilful people are loved and sought, but unskilful people are generally despised. 6. A man often neglects his duties, while thinking of his pleasures. 7. Most sacred duties have often been neglected, while we have been devoted too much to pleasure. 8. The hat of the victor had been adorned with flowers. 9. The most valiant of the army will be rewarded, according as their actions are acknowledged. 10. Thy sister is loved and praised by her teacher, because she is diligent and attentive; but thou wilt be censured by thine, because thou dost not like to work. 11. Charles has been punished because he had not finished his exercise. 12. We were praised by our teacher because we were diligent. 13. Our friend has been punished because he had been neglectful. 14. Thou hast had the pleasure of passing some days with thy friends in the country; thou hast been praised and rewarded by them because thy teacher has given thee a favourable testimony. 15. His brother would have been better received.

PASSIVE VERBS IN THE SUBJUNCTIVE.

EXAMPLES.

Er wollte nicht erlau'ben, daß jener Mann ge'rufen werde.	He would not allow that that man should be called.
Sie hatten verge'bens gehofft', daß die vielen kleinen Her'zogthümer in Provin'zen ein'getheilt würden.	They had vainly hoped that the many little dukedoms would be divided into provinces.
Man glaubt, daß bei diesem letzten Sturme viele Schiffe verschla'gen worden seien.	It is supposed that, by this late (last) storm, many vessels have been cast away.
Er erzähl'te mir, daß meine Ab'handlungen über diesen Ge'genstand sehr gelobt' worden wären.	He told me that my dissertations concerning this affair had been very much lauded.
Da die fürst'liche Fami'lie ge'genwärtig ist, so vermu'thet man, daß diesen Abend ein großes Concert' werde gege'ben werden.	Since the princely family is present, it is conjectured that a great concert will be given this evening.
Ich hoffe, daß in kurzer Zeit alle Hin'dernisse, von ihm werden überwun'den worden sein.	I hope that in (a) short time all hindrances will have been surmounted by him.

VOCABULARY.

Ab'brechen, to break off, crop, pluck.	Dafür'halten, to be of opinion, to deem.	Klagen, to complain, lament.
Auf'fallend, startling, striking, remarkable.	Dar'bieten, to present, offer.	Lösen, to solve, unriddle.
Aus'rufen, to call out.	Ehren, to honour, respect, esteem.	Ora'kel, *n.* oracle.
Äu'ßere, *n.* countenance, exterior.	Ein'nehmen, to occupy, take possession of.	Räthsel, *n.* riddle, enigma.
Befürch'ten, to fear, apprehend.	Fort'schleppen, to drag, pull along.	Spiel, *n.* game, play.
Begna'digen, to pardon, favour.	Graben, to dig, grub, ditch.	Troja, *n.* Troy.
Beißen, to bite.	Griechisch, Greek, Hellenic.	Ü'bermaß, *n.* excess, superfluity.
Besa'tzung, *f.* garrison.	Hinterge'hen, to deceive, delude.	Ü'brigens, as for the rest, besides.
Beste'chung, *f.* corruption, bribery.	Hirsch, *m.* stag, hart, deer.	Verkün'digen, to announce, predict.
Cartha'go, *n.* Carthage.		Vermu'then, to suppose, presume, think.

EXERCISE 128.

Translate into English:—

1. Es wird gesagt, daß eine Vorstellung von dem Schauspieler gegeben werde. 2. Der Nachbar glaubt, daß die Eltern von dem Knaben getäuscht werden. 3. Die Kinder sagten, der Hirsch würde von dem Jäger geschossen. 4. Man befürchtet, die Leute würden von dem Hunde gebissen. 5. Man vermuthet, der Freund sei vom Freunde hintergangen worden. 6. Der Vater meinte, daß das Stück von den Kindern gespielt worden wäre. 7. Er erzählte mir, daß die Blumen in seinem Garten von den Mädchen wären abgebrochen worden. 8. Der alte Soldat rief aus, daß sein Feldherr nie von ihm werde vergessen werden. 9. Die Mutter sagte, es werde diesen Nachmittag im Garten von ihr gegraben werden. 10. Ich möchte wissen, ob er von Ihnen würde geehrt worden sein. 11. Ich dachte nicht anders, als daß das Spiel von ihm werde gewonnen worden sein. 12. Das Orakel verkündigte ihm, er werde siegen. 13. Er sagte mir, er werde von Jedermann geliebt und geachtet. 14. Er behauptet, das Räthsel sei durch ihn gelöst worden. 15. Die Geschichte meldet, daß Troja von den griechischen Fürsten zerstört worden sei. 16. Er sagte ihm, er würde seinetwegen Alles zu thun bereit sein. 17. Der Freund beklagte sich, daß er so wenig von mir besucht würde. 18. Man sagt, Ungarn sei durch Bestechung, nicht durch Gewalt der Waffen besiegt worden. 19. Mein Nachbar sagte mir, das Äußere dieses Mannes böte nichts Auffallendes dar, aber seine Seele wäre geziert durch eine Menge trefflicher Eigenschaften. 20. Der alte Cato schloß eine jede Rede mit den Worten: Übrigens halte ich dafür, daß Carthago zerstört werden muß. 21. Man vermuthet, die Festung sei von den Feinden eingenommen worden, allein die Besatzung werde begnadigt worden sein. 22. Der Jüngling sagte, es werde noch Vieles von ihm gethan werden. 23. Der betrübte Vater glaubt, sein Sohn werde von dem erbitterten Feinde erschossen worden sein. 24. Die Freundin behauptete, daß das Unglück durch die Schuld des Nachbars herbeigeführt worden wäre. 25. Der Arme klagte, daß er gewaltsam fortgeschleppt worden wäre.

EXERCISE 129.

Translate into German:—

1. It was said those children would be loved by everybody. 2. The teacher believes that the exercise could have been learnt by the scholars. 3. The gardener said it would be dug by him to-morrow in the garden. 4. We wish that your friends may be loved and esteemed by you. 5. We did not believe that we should ever have been praised by our teachers, and that we should have satisfied them in everything. 6. It is impossible that you could have received the intelligence before us, except it might have been communicated to you by telegram. 7. How is it possible that this undertaking could have been finished by you? 8. We doubt very much that we can ever be rewarded for our troubles, and that the promises can ever be fulfilled. 9. How could it be possible that that people was governed badly, when it had so wise and good a prince? 10. The poor slave complained that he had been forcibly dragged along, and in the excess of his grief he cried out, "Oh, that I had never been born!"

IDIOMS OF PREPOSITIONS.

The preposition wegen is often compounded with the genitive of personal pronouns, which in this connection substitute t or et for the final r, as:—Meinetwegen (instead of meinerwegen), on my account, for my sake (*lit.*, on account of me); Seinetwegen nur bin ich gekommen, on his account only have I come.

The preposition zu is often used after certain verbs (as, machen, werden, wählen, etc.) to mark the result of an action, or the end or destination of a thing, as:—Sie haben ihn zum Feind gemacht, you have made him (to) an enemy, *or*, you made an enemy of him; Das Eis wird zu Wasser, the ice becomes (to) water; Sie wählten ihn zum Kaiser, they elected him (to the) emperor.

Verdacht auf Jemand haben, or Jemand im Verdachte haben (*lit.*, to have suspicion upon one, *or* to hold one in suspicion), answers to our "to suspect," as:—Ich habe Verdacht auf ihn, or Ich habe ihn im Verdachte, I suspect him, *or* I have suspicion of him.

EXAMPLES.

Haben Sie gehört', an was für einer Krankheit der Rei'sende gestor'ben ist?	Have you heard what disease the traveller (has) died of?
So viel ich weiß, ist er an der Cho'lera gestor'ben.	As far as I know, he (has) died of the cholera.
Alexan'der der Große starb an einer Krankheit zu Ba'bylon im dreiunddrei'ßigsten Jahre seines Lebens.	Alexander the Great died of (a) sickness at Babylon in the thirty-third year of his life.
Auf wen haben Sie Verdacht'?	Whom do you suspect? (Upon whom have you suspicion?)
Ich habe ihn im Verdach'te, mich beraubt' zu haben.	I suspect him of having robbed me. (I have him in suspicion to have robbed me.)
Nachdem' ich zu Nacht gespeist' haben werde, gehe ich aus.	After I shall have supped I shall go out. (After I shall have eaten at night, I go out.)
Er ist nach zehn Uhr zu mir gekom'men.	He came to me after ten o'clock. (He is come to me after ten o'clock.)
Er ist wegen seiner Krankheit nicht gegan'gen.	On account of his illness he did not go. (He is on account of his illness not gone.)

VOCABULARY.

An'kleiden, to dress, attire.
Auf'wärterin, *f.* female servant, waiting-woman.
Aus'zehrung, *f.* consumption.
Baden, to bathe.
Früh'stücken, to breakfast.
Krankheit, *f.* sickness, illness, malady, disease.
Mittag, *m.* noon, mid-day.
Mit'ternacht, *f.* midnight.
Speisen, to eat; zu Mittag speisen, to dine.
Verdacht', *m.* suspicion.
Weiter, farther, more distant.
Werfen, to throw, cast.
Worauf', whereupon, on which.
Zuerst', at first, for the first.

EXERCISE 130.

Translate into English:—

1. Wissen Sie nicht, an was für einer Krankheit Ihre Nichte gestorben ist? 2. So viel ich gehört habe, ist sie an der Auszehrung gestorben. 3. Viele sind in diesem Jahre an der Cholera gestorben. 4. Weiß man nicht, wer die silbernen Löffel gestohlen hat? 5. Nein, aber man hat Verdacht auf einen Bedienten des Hauses. 6. Man hatte zuerst eine alte Aufwärterin im Verdachte. 7. Er hat mich im Verdachte, ihn vorsätzlich beleidigt zu haben. 8. Ich weiß wirklich nicht, auf wen ich meinen Verdacht werfen, und worauf ich ihn stützen soll. 9. Nachdem ich mich angekleidet, und nachdem ich gefrühstückt haben werde, will ich ihn besuchen. 10. Nachdem er zu Mittag gespeist hatte, las er die Zeitung. 11. Nachdem er sich gebadet hatte, machte er einen Spaziergang. 12. Nach zehn Uhr des Abends besuchte er mich noch. 13. Nach Mitternacht werden wir unsere Reise weiter fortsetzen. 14. Es giebt Menschen, welche nach diesem Leben kein anderes erwarten. 15. Ich freue mich seinetwegen mehr, als meinetwegen. 16. Ihretwegen habe ich die Reise unternommen. 17. Euretwegen ist der Vater so betrübt. 18. Unsertwegen brauchen Sie sich nicht zu schämen. 19. Mein Bruder war seiner selbst nicht mehr mächtig. 20. Hast Du Herrn N. selbst, oder seine Frau gesehen? 21. Ich habe ihn selbst nicht nur gesehen, sondern auch gesprochen. 22. Ein treuer Soldat stirbt lieber, als daß er zum Verräther wird.

EXERCISE 131.

Translate into German:—

1. Are we obliged to wait for our friend? 2. No, not on his account. 3. This man is tested on account of his perfidy. 4. Do not grieve on account of us! 5. On my account you may do what you like. 6. My brother died of consumption in the nineteenth year of his age. 7. Do you know who has stolen your gold watch? 8. No, but I am suspicious of that man who came to our house yesterday. 9. At first I suspected a servant of the house. 10. After I had performed my last voyage, I applied myself to the study of the living languages. 11. After we had dined, we took an airing on horseback. 12. After he had breakfasted, he visited his brother-in-law. 13. This lady wants eighteen ells of muslin for a dress. 14. That youth became a doctor. 15. That speculation made our neighbour a rich man. 16. He told me he should on his own account speak to his father.

TRANSLATION FROM GERMAN.

In der stillen Bay des Pailen, hörten wir zum ersten Male das bis jetzt unmöglich geglaubte: singende Fische. Von der Seite, um uns her, tief aus dem Grunde heraus, tönte überall ein wunderbarer, halb klagender schwimmender Ton, fast wie ein ferner melodischer Orgel- und Glockenklang, der, wie unser Pilot versicherte, von einer Art Fischen herrührte.

Es soll ein kleiner, sehr schöner Fisch sein, der diesen Laut von sich giebt, und er wird äußerst selten gefangen. Vor einiger Zeit bekam einmal einer der hiesigen Fischer einen solchen zufällig in sein Netz, und noch in Netze gab er den Laut von sich. Wahrscheinlich in abergläubischer Furcht ließ er ihn aber augenblicklich wieder frei, denn die Leute erzählen sich hier natürlich die wunderbarsten Sachen von dem Fisch—oder vielmehr von dem Tönen—die sie für die Seelen der ertrunkenen halten.

KEY TO EXERCISES.

Ex. 116.—1. The French conquered Spain by force of arms. 2. The avalanches in Switzerland often fall into the valleys with tremendous force. 3. They forcibly drag away the inhabitants of this country. 4. He could do nothing with all his power. 5. The Greeks defended themselves against the Persians with all their might. 6. The weaker man must necessarily obey the stronger. 7. Almost all Asia obeyed the will of the Romans. 8. In order to prolong his life, he was necessarily obliged to work. 9. Themistocles was forced to seek an asylum at the Persian court. 10. My friend confidentially entrusted me with an important secret yesterday evening. 11. After school was over, the children played under the trees of the garden. 12. All present dressed according to the fashion of 1789. 13. On account of his official duties, he had little leisure left for pleasure. 14. Schiller could now devote himself at his leisure to literary pursuits at Mannheim. 15. I have inadvertently taken another umbrella. 16. Errors arise through misunderstandings and oversights.

Ex. 117.—1. Die Einwohner Holstein's vertheidigten sich mit all ihrer Macht gegen die Dänen. 2. Wilhelm der Eroberer unterjochte England mit Gewalt der Waffen. 3. Diese tapfern Soldaten bahnten sich ihren Weg mit furchtbarer Gewalt durch die Reihen der Feinde. 4. Man hinderte ihn gewaltsam an der Flucht. 5. Lieben Sie die deutsche Sprache? 6. Ja, ich liebe sie, aber vorzugsweise liebe ich die italienische Sprache. 7. Jetzt ist er besonders mit der deutschen und spanischen Sprache beschäftigt. 8. Glücklicher Weise fand ich meinen Freund zu Hause. 9. Er ist genöthigt, den Befehlen seiner Vorgesetzten zu gehorchen. 10. Die meisten Leute kleiden sich nach der französischen Mode. 11. Ich nahm unwissentlich den Hut eines Andern. 12. Glücklicher Weise entdeckte mein Freund die Gefahr, welche ihm drohte. 13. Scherzweise sagte er mir manche Wahrheit. 14. Unter vier Augen können Sie manche Beleidigungen sagen. 15. Die Fürsten Deutschlands verfahren eigenmächtig im Regieren ihrer Länder.

Ex. 118.—1. Did you see this neat little garden? 2. No, for I admired that pretty cottage. 3. It belongs to two old people, whom I know. 4. What kind of pretty little animals are those? 5. There are a great many young lambkins in the garden. 6. This girl plays with her little brother. 7. Will you give me that little chest? 8. Will you have that one on the little table? 9. Look, what a neat little hat! 10. The little child is delighted with his little kitten and with his gosling. 11. So arrange it that you may be at my house by Saturday morning. 12. Do we make it in such a manner that it is useful for both purposes? 13. He shall so arrange it that he can take his books with him. 14. At all events, I will so arrange it that I shall be with you at ten o'clock. 15. We will so arrange it that we by no means come too late. 16. Tell your brother he should so arrange it that it may be understood by everybody.

Ex. 119.—1. Väterchen, willst du mir das Lämmchen kaufen? 2. Nein, mein Töchterchen, aber ich werde dir das Gänschen und die Fischchen kaufen. 3. Haben Sie jenes niedliche Häuschen gesehen? 4. Nein, ich bewunderte jenes schöne Gärtchen. 5. Marie spielt mit dem Kätzchen, und ihr Brüderchen mit dem Fischchen. 6. Sehen Sie, was für ein schönes Kästchen das ist. 7. Die Menschen sollten zu jeder Zeit ihre Gedanken auf Gott richten. 8. Richten Sie es so ein, daß ich Sie morgen zu Hause finde. 9. Ich hoffe, Sie werden es so einrichten, daß Sie Montag Morgen ankommen können. 10. Was ist dieser Garten werth? 11. Er ist mehr werth als Sie glauben. 12. Was waren diese Bücher vor zehn Jahren werth? 13. Wie hoch willst du gegen dieses Pferd wetten? 14. Es gilt fünf Pfund.

Ex. 120.—1. Tell me whether that is your own horse? 2. Have these children much property of their own? 3. Their parents were very rich. 4. I think it is very singular that he does not use his own horses, but drives with others. 5. I have no house of my own. 6. Is that his own carriage, or has he only hired it? 7. I consider this question very singular. 8. This is my own conviction, according to which I act. 9. This old merchant is a very singular man. 10. Every man has his own faults. 11. Have you ever been in this house? 12. I have never been there. 13. I think it my duty not to find fault with him. 14. I shall never deviate from my principles. 15. Have you not been with my brother yet? 16. I have just seen him. 17. Has your daughter already been in my garden? 18. She is not yet gone out. 19. Have you ever travelled over so interesting a country? 20. I have already seen many beautiful things, but I never forget beautiful Switzerland.

Ex. 121.—1. Der denkende Mensch weicht nie vom Pfade der Tugend ab. 2. Haben Sie je solch ein reizendes Land bereist, als Italien oder die Schweiz? 3. Nein, aber ich werde nie die schönen Thäler des Rheines vergessen. 4. Glauben Sie ja nicht Alles, was man Ihnen sagt. 5. Der Vater kommt so eben mit seinem Sohne und dem Onkel von der Reise. 6. Hält der Lehrer viel von seinen Schülern? 7. Ja, er hält sie für sehr gut. 8. Er hält viel von einem bequemen Leben. 9. Dieser Mensch hält zu viel von seinen Fähigkeiten.. 10. Johann ist sein Feind, aber er glaubt, er sei sein Freund. 11. Ich habe ein eigenes Haus, und mein Bruder hat keins. 12. Ist dies Ihre eigene Erfindung? 13. Ja, sie ist's, aber ich finde diese Frage sehr eigen. 14. Dieser Mensch hat eine eigene Idee. 15. Finden Sie Ihren Freund nicht sehr eigen? 16. Ja, er hält sich über Jedermann auf. 17. Sind Sie je im Museum gewesen? 18. Ja, ich bin verschiedene Male dort gewesen. 19. Sind Sie schon in dem Garten meines Oheims gewesen? 20. Um Andern Ruhe zu verschaffen, opfert er seine eigene auf.

Ex. 122.—1. He that wishes to gain godliness and what is highest in life must not fear work and struggling. 2. He who wishes to win must venture. 3. I prize this book; he who steals it is a thief. 4. He who is resolved to love nothing but his image, has nothing to love but himself. 5. He who doubts, despairs. 6. He that fights against his country is a traitor. 7. He who ventures into danger perishes in it. 8. He who does not assist the oppressed, also deserves no assistance. 9. He who is determined to set himself against fate is a fool. 10. Are you by birth an Englishman or American? 11. I am neither; I am a German by birth. 12. Who is your friend? 13. She is an American, born in New York. 14. Where was your friend born? 15. He is a native of England. 16. In what country were you born? 17. I was born in the United States of North America. 18. I make fun of this man. 19. You should not make fun of him. 20. He makes fun of everybody.

Ex. 123.—1. Wer den Armen beisteht, wird göttliche Hülfe erlangen. 2. Derjenige, welcher überall Eingang zu haben wünscht, muß goldene Schlüssel haben. 3. Wer für sein Vaterland streitet, verdient Auszeichnung. 4. Wer Deutsch lernen will, muß sich einige Mühe geben. 5. Wer für seinen König stirbt, stirbt mit Ruhm. 6. Wer Hochverrath begeht, stirbt gewöhnlich auf dem Blutgerüste. 7. Sie sind unter einem glücklichen Sterne geboren. 8. In welchem Lande wurden diese Damen geboren? 9. Sie wurden in Italien geboren, im Jahre 1795; aber ihre Mutter wurde in England geboren. 10. Sind diese Damen aus Deutschland gebürtig? 11. Nein, sie sind aus Frankreich gebürtig. 12. Unser Musiklehrer ist aus Italien gebürtig, und ist in Florenz geboren. 13. Ich werde thun, was ich versprochen habe. 14. Zeigen Sie mir, was Sie gefunden haben. 15. Was den Ruhm dieses Helden erhöht, ist seine Bescheidenheit. 16. Laßt uns ihm gewähren, was wir zuerst verweigerten. 17. Du hast uns nie gesagt, was sie dir anvertraut haben. 18. Warum machen Sie sich lustig über das Unglück der Unterdrückten? 19. Das Obst, welches wir in dem Garten unsers Nachbars sahen, war nicht so gut als das, welches in Ihrem Garten wuchs.

Ex. 124.—1. Excuse me, sir; it was not done intentionally. 2. If he did it intentionally, he is by no means to be excused. 3. Although you did not do it purposely, still it is culpable. 4. Had you done it purposely, then you ought to be ashamed of yourself. 5. They have liberated the prisoner on purpose. 6. This man has not intentionally brought on this delay. 7. As long as such men are at the head of the State we cannot expect an improvement. 8. As long as I have no employment, I cannot be contented. 9. As long as you are well-behaved, you shall have everything that you require. 10. As long as the world has stood, no one has made such an assertion. 11. I will work for you as long as you are ill. 12. As long as he was absent we took care of his whole family. 13. You can lodge in my house as long as you like. 14. If he does not stay so long, he cannot receive my letters any longer. 15. This man works from day-break till late at night. 16. From this time forth I shall take a walk every day from the river to the

mountain. 17. I have now received a letter, and shall go to my friends as soon as I can. 18. I shall have arranged all my affairs till the twentieth of January. 19. As I have now arrived, I shall speak to him as soon as I see him. 20. When they came at last, it had become night.

Ex. 125.—1. Die Bücher, welche ich bei Ihnen gekauft habe, können Sie auf meine Rechnung setzen. 2. Die Sieger machten sich auf Rechnung ihrer Feinde lustig. 3. So lange der Mensch Beschäftigung hat, kann er zufrieden sein. 4. So lange die Welt stehen wird, wird Gottes Wort nicht untergehen. 5. Ich werde für meinen Freund arbeiten so lange er krank ist. 6. So lange die Schüler fleißig sind, wird ihr Lehrer sie loben. 7. Sie können bei meiner Familie bleiben so lange Sie wollen. 8. Wenn Sie bleiben wollen, bis ich diese Briefe fertig habe, so können Sie dieselben meinem Freunde mitnehmen. 9. Von nun an werden wir mehr Zeit auf das Studiren verwenden. 10. Das Schiff war dem Winde und den Wellen Preis gegeben. 11. Von Tagesanbruch bis spät in die Nacht war die Stadt dem Feuer des Feindes ausgesetzt. 12. Die Sonne bricht zwischen den Wolken hervor. 13. Die Athener erklärten, Niemand als Jupiter sollte von nun an in Athen regieren. 14. So lange mein Innerstes mein Betragen billigt, wird (soll) das Urtheil der Leute mich nicht beunruhigen. 15. Er hat den letzten Punkt seiner Rede besonders hervorgehoben. 16. Sie machten sich auf seine Rechnung lustig, und er nahm es nicht wahr.

CHEMISTRY.—VII.

[Continued from p. 134.]

STRUCTURE AND LUMINOSITY OF FLAME—BUNSEN BURNER—THE DAVY SAFETY LAMP—THE HALOGENS.

If we apply a lighted match to the wick of a candle, the heat converts a portion of the wax into vapour, which is lighted by the match, and as long as the candle burns the process continues, *i.e.*, the heat of the flame melts the wax, which is first sucked up by the wick and converted into vapour, and then burns, giving out light and heat. If such a flame be closely examined, it will be seen to consist of three parts—a dark inner zone *m*, Fig. 27, a middle zone *i*, which gives out light, and an outer zone in which the flame is much less luminous. The oxygen of the air penetrates the mass of heated vapour from the outside, so that in the outer zone *e* there is enough oxygen to burn both the hydrogen and the carbon of the combustible vapour; in the zone *i* there is only enough oxygen to burn the hydrogen, and the carbon atoms remain for a short time unburnt; they are intensely heated by the burning hydrogen, and so become white-hot, giving out much light; in the inner zone no oxygen is left, and so neither hydrogen nor carbon is burnt. This can be proved by holding a piece of glass tube with one end in the dark zone, as in Fig. 27, when the unburnt hydrocarbons can be lighted at the top.

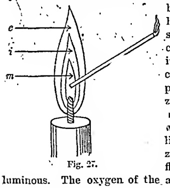


Fig. 27.

Most substances which produce gases when combined with oxygen burn with a feeble light, as sulphur, which produces the gas SO_2, but when a solid is produced, as when phosphorus burns, the flame is luminous.

The facts above stated serve to explain the luminosity of a coal gas flame, and the same central zone of unburnt gas can be detected.

When coal gas is mixed with the proper quantity of air, the mixture burns with a perfectly non-luminous flame which, however, gives out as much heat as the luminous flame. The simplest apparatus for this purpose is the Bunsen burner, Fig. 28. It consists of a small jet of gas, which escapes at the lower part of a brass tube about three or four inches long. Just below the level of the gas jet the brass tube is perforated with two large holes. As the gas passes up the tube, it sucks in air through these holes, thus a mixture of gas and air reaches the top of the tube, which when lighted burns with a non-luminous flame. It is sometimes erroneously supposed that the air burns too, and that more heat is produced in the Bunsen burner than when the gas is burnt at an ordinary jet; this is not the case, exactly the same amount of heat is produced however the gas is burnt, provided that the combustion is complete.

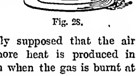


Fig. 28.

Instead of the above arrangement, another form of air burner is frequently employed; the gas is liberated underneath a piece of fine wire gauze, Fig. 29, which is clamped to an iron cylinder; the wire gauze conducts away the heat so rapidly that the flame is prevented from passing through. This fact can be illustrated by depressing a piece of wire gauze over a flame, Fig. 30, when the gas

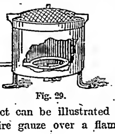


Fig. 29.

above the gauze will remain unburnt. The well-known lamp invented by Sir Humphry Davy for the coal miner depends for its safety on the same principle; the flame of an oil lamp is completely surrounded with fine copper gauze, so that even if the lamp be placed in an atmosphere containing marsh gas, the gas will only burn on the inside of the gauze. Unfortunately, so much light is cut off by the gauze that there is a great temptation to the miner to open the lamp and risk the explosion. If a Davy lamp be exposed to a strong current of air, the flame may be passed through the gauze too swiftly for it to be extinguished.

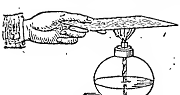


Fig. 30.

Carbon disulphide (CS_2). When the vapour of sulphur is passed over red-hot coke, the elements combine to form a new substance, carbon disulphide, CS_2; this is condensed by passing the vapour into vessels cooled with ice, and then forms a mobile, volatile liquid which usually has a most disgusting odour, but when perfectly pure has no unpleasant smell. Carbon disulphide is extremely useful as a solvent, as it dissolves many substances which are insoluble in water. Thus it dissolves nearly all fatty bodies, also phosphorus, sulphur, iodine, etc.; with gutta-percha and india-rubber it forms very adhesive solutions. When mixed with methylated spirit and burnt in an ordinary spirit lamp it produces sulphur dioxide, SO_2, and so furnishes an excellent and convenient method of disinfecting a room. Carbon disulphide should never be brought near a light, as it gives off vapour very readily (boils at 46° Cent.), and the vapour lights at a comparatively low temperature, 150° Cent., *i.e.*, far below a red heat.

When carbon monoxide, CO, and sulphur vapour are heated they combine to form a colourless gas called carbon oxysulphide, COS.

FLUORINE—CHLORINE—BROMINE—IODINE.

We now come to a group of elements which are closely connected with each other, and are called the *Halogens* or salt-formers, because they produce, when combined with some of the metals, bodies closely resembling common salt. The group consists of—Fluorine, atomic weight, 19; Chlorine, atomic weight 35·5; Bromine, atomic weight 80; Iodine, atomic weight 127. Fluorine and chlorine are gases; bromine is a dark brown liquid; and iodine is a black shining solid. It will be noticed that these elements pass from the gaseous to the solid condition as the atomic weight rises.

The halogens all unite with hydrogen to form colourless gases which fume in the air and dissolve readily in water, forming very acid solutions; they are strongly electronegative; they combine energetically with the metals and, but feebly with oxygen and carbon.

Fluorine (F), atomic weight 19. This colourless gas was prepared in 1886 by a French chemist, Moissan, who obtained it by decomposing liquefied hydrogen fluoride, HF (containing in solution a little potassium fluoride), *at a very low temperature*, $-23°$ Cent., with a powerful current of electricity. Fluorine combines at ordinary temperatures most energetically with all known elements excepting oxygen, nitrogen, chlorine, and bromine; it attacks glass, porcelain, silver, lead, and all organic bodies; it is therefore impossible to find a vessel which would withstand its action, and it remained unknown until Moissan separated it at a low temperature. It has lately been liquefied at a temperature of $-185°$, forming a yellow liquid which does not act on glass, etc., but still unites with hydrogen.

Hydrogen fluoride, Hydrofluoric acid (HF). This substance can be prepared perfectly pure by passing hydrogen over heated silver fluoride, and is obtained as a colourless, fuming, poisonous gas. It is more convenient to prepare a strong solution by heating powdered fluorspar, or "Blue John," a substance occurring in Derbyshire and other places, with strong sulphuric acid in lead or platinum vessels—

$$\underbrace{CaF_2}_{\text{Calcium fluoride or fluorspar.}} + H_2SO_4 = \underbrace{CaSO_4}_{\text{Calcium sulphate.}} + 2HF$$

Both the gas and the solution of hydrofluoric acid can be used to etch glass. A watch glass is gently heated until it is hot enough to melt some white wax which is gently rubbed on its convex surface; when the wax is cold, some letters or figures are drawn through the wax with the point of a pin so as to expose the glass. A little circular dish of lead is made by hammering up a piece of sheet lead; some strong sulphuric acid is placed in the lead dish, and on it is thrown some powdered fluorspar; on gently heating the mixture, the fuming hydrofluoric acid is evolved; a little cold water is now placed in the watch glass to prevent the melting of the wax, and the watch glass placed as a cover on the leaden dish. After two or three minutes the watch glass is taken off, washed, warmed, and cleaned, when the design will be found etched into the glass. The hydrogen fluoride attacks the silica in the glass, converting it into a colourless gas—silicon tetrafluoride. SiF_4.

When silicon fluoride is passed into water it is decomposed into gelatinous particles of silicon hydrate or silicic acid and hydrofluosilicic acid—

$$3SiF_4 + 4H_2O = \underbrace{Si(HO)_4}_{\text{Silicic acid.}} + \underbrace{2H_2SiF_6}_{\text{Hydrofluosilicic acid.}}$$

Chlorine (Cl), atomic weight 35·5. This pale yellowish green gas is most conveniently made by gently heating black oxide of manganese with hydrochloric acid in a glass flask furnished with cork and delivery tube as usual—

$$4HCl + MnO_2 = Cl_2 + 2H_2O + \underbrace{MnCl_2}_{\text{Manganous chloride.}}$$

It is better to pour the acid in first and then add the black oxide of manganese.

Instead of using hydrochloric acid, we can make it in the flask by adding salt and sulphuric acid—

$$\underbrace{2NaCl}_{\text{Salt.}} + 2H_2SO_4 + MnO_2 = Cl_2 + 2H_2O + \underbrace{Na_2SO_4}_{\text{Sodium sulphate.}} + \underbrace{MnSO_4}_{\text{Manganous sulphate.}}$$

Almost any oxidising substance can be used to oxidise the hydrogen in the hydrochloric acid and so liberate the chlorine, as red lead (Pb_3O_4), etc.

In another process the oxygen in the air is used; hydrogen chloride is mixed with air and passed over heated bricks—

$$4HCl + O_2 = 2H_2O + 2Cl_2.$$

Deacon discovered that if the bricks were soaked in copper sulphate solution before heating, the reaction was carried out more quickly and efficiently. This is an example of catalytic action, as the copper sulphate remains unchanged at the end of the operation. Chlorine can also be prepared by the action of dilute acids on bleaching powder, the so-called "chloride of lime."

On the large scale, chlorine is usually prepared by heating black oxide of manganese with hydrochloric acid; at one time fresh oxide of manganese was used for each operation, but Weldon perfected a process by which the oxide could be used over and over again. On reference to the first equation, it will be seen that the oxide is converted into manganous chloride ($MnCl_2$), which remains dissolved in an acid solution. This dark-coloured liquid is neutralised by adding chalk; after settling, slaked lime $Ca(HO)_2$ is added to the clear liquid, which precipitates the manganese as manganous hydrate $Mn(HO)_2$. This precipitate is warmed to about 60° Cent. by passing steam through it, and then air is blown in, when the manganous hydrate is converted into a black mud which is practically MnO_2, and can be used for the preparation of chlorine. This simple improvement has had a most marked effect in cheapening chlorine and, indirectly, every ream of paper and every yard of calico.

Chlorine bleaches only in the presence of water—

$$2Cl + H_2O = 2HCl + O.$$

Some believe that it is the oxygen at the moment that it is liberated, "nascent oxygen," which effects the bleaching. In consequence of this power of liberating oxygen in the presence of water, chlorine is a powerful disinfectant, *i.e.*, it destroys unpleasant smells, disease germs, etc.; it also decomposes instantly ammonia, NH_3, and sulphuretted hydrogen, H_2S, two of the chief offensive products of putrefaction. Chlorine is to some extent an antiseptic, *i.e.*, it prevents putrefaction.

Two volumes of chlorine dissolve in one volume of water, and the solution when cooled to the freezing-point deposits yellow crystals of chlorine hydrate, $Cl_2 + 10H_2O$. It is best, therefore, to collect chlorine over hot water, or by displacement, as it is more than twice as heavy as air. Chlorine has a faint *yellowish green* colour, hence its name, and a characteristic odour; when inhaled, even in small quantities, it produces violent coughing often followed by inflammation of the lungs. Chlorine has been liquefied at a pressure of six atmospheres at 0° Cent.

Hydrogen chloride, often called hydrochloric acid gas (HCl). This colourless fuming gas is prepared by the action of strong sulphuric acid on common salt at ordinary temperatures. The reaction is

$$NaCl + H_2SO_4 = HCl + \underbrace{HNaSO_4}_{\text{Acid sodium sulphate.}}$$

(An acid salt is one in which all the hydrogen in the acid has *not* been replaced by a metal. A neutral or normal salt is one in which all the hydrogen has been replaced by a metal, *see* Vol. III. p. 259.) If the temperature be raised, the sulphuric acid decomposes twice as much salt—

$$2NaCl + H_2SO_4 = 2HCl + \underbrace{Na_2SO_4}_{\text{Neutral sodium sulphate.}}$$

The gas must be collected over mercury or by displacement, as it is very soluble in water—one volume of water dissolving about 500 volumes of the gas. This solution of hydrogen chloride gas in water forms the hydrochloric or muriatic acid of commerce, sometimes called "spirit of salt."

The composition of hydrogen chloride can be shown by mixing one volume of chlorine with one volume of hydrogen, and exposing the mixture to daylight, when it will be found that the colour of the chlorine gradually disappears and eventually

two volumes of colourless hydrogen chloride are formed. If the mixture is placed in the sunlight, it will explode.

Hydrogen chloride exists in the gases emitted by volcanoes; it can be liquefied by a pressure of 40 atmospheres at 10° Cent.; it fumes strongly in the air because it combines with the aqueous vapour and forms a mist of hydrochloric acid. Ordinary hydrochloric acid, which is usually yellow owing to the presence of a little iron, often contains traces of arsenic and sulphuric acid; it is obtained in enormous quantities as a bye-product in the manufacture of washing soda, and is extensively used for making chlorine, for dissolving various metals, as tin, zinc, iron, and in the manufacture of sal ammoniac ($AmCl$). It dissolves many substances which are insoluble in water, and is therefore very useful in analysis. It forms a series of salts called the chlorides, which are all soluble in water with three exceptions—silver chloride ($AgCl$), mercurous chloride or calomel (Hg_2Cl_2), and lead chloride ($PbCl_2$). A mixture of about three volumes of hydrochloric acid with one of strong nitric acid is called *aqua regia* because it dissolves gold and platinum.

Oxides and oxy-acids of chlorine. There are two oxides and four oxy-acids of chlorine—Cl_2O, chlorine monoxide; Cl_2O_4, chlorine peroxide; $HClO$, hypochlorous acid; $HClO_2$, chlorous acid; $HClO_3$, chloric acid; $HClO_4$, perchloric acid. Most of these are yellowish gases or yellowish red liquids, which are very unstable, being particularly liable to explode when mixed with combustible substances, as phosphorus, sulphur, sugar, etc

Peroxide of chlorine (Cl_2O_4) is prepared as a yellowish gas by very cautiously and gently warming a mixture of finely powdered potassium chlorate and strong sulphuric acid. It explodes violently when heated, or when mixed with phosphorus, sugar, etc. If a little heap of chlorate of potash and small pieces of phosphorus be placed at the bottom of a conical glass, such as an old-fashioned champagne glass, and the glass be filled up by gently pouring in water, a violent reaction, attended with flashes of light, will take place as soon as we pour some strong sulphuric acid on to the chlorate of potash by a thistle funnel, Fig. 31, Cl_2O_4 being liberated and immediately decomposed by the phosphorus. For a similar reason, a mixture of equal parts of powdered sugar and potassium chlorate is at once fired by a drop of strong sulphuric acid.

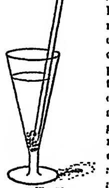


Fig. 31.

Hypochlorous acid ($HClO$). This is a weak unstable acid prepared by shaking chlorine water, *i.e.*, a solution of chlorine in water, with precipitated oxide of mercury or with chalk—

$$CaCO_3 + H_2O + 4Cl = CO_2 + 2HClO + \underbrace{CaCl_2}_{\text{Calcium chloride.}}$$

Its principal interest is its intimate connection with the so-called "chloride of lime" or bleaching powder. There has been much discussion as to the formula of bleaching powder, but a formula originally proposed by Odling, $CaOCl_2$, is now generally accepted. Bleaching powder is prepared by placing slaked lime in trays in a chamber made of stone slabs; the chamber is filled with chlorine and then closed; the chlorine is gradually absorbed by the lime—

$$\underbrace{2Ca(HO)_2}_{\text{Slaked lime.}} + 4Cl = 2CaOCl_2 + 2H_2O$$

Bleaching powder owes its value to the fact that chlorine may be easily liberated from it by the action of any ordinary acid, and thus furnishes us, so to speak, with chlorine in a portable shape. When treated with water, bleaching powder is decomposed into a mixture of calcium chloride and calcium hypochlorite—

$$2CaOCl_2 = CaCl_2 + \underbrace{Ca(OCl)_2}_{\text{Calcium hypochlorite.}}$$

Stains from ordinary ink, fruit, wine, etc., can easily be removed by the aid of bleaching powder. Some bleaching powder is thoroughly mixed up with water and then strained through a piece of calico to remove lumps. The fabric is soaked in this solution for a few moments and then immersed in a second vessel containing either vinegar or dilute hydrochloric acid. Chlorine is at once evolved and the colour destroyed. The fabric must then be thoroughly washed.

Chloric acid ($HClO_3$). This acid has only been prepared in solution; it forms salts, termed chlorates, which are all soluble in water; the most important is potassium chlorate, $KClO_3$. This salt can be prepared by passing chlorine through a hot strong solution of caustic potash, KHO—

$$6Cl + 6KHO = KClO_3 + \underbrace{5KCl}_{\text{Potassium chloride.}} + 3H_2O$$

The chlorate is separated from the chloride by evaporating the solution to a small bulk, when the chlorate crystallises out, leaving the potassium chloride in solution. When chlorates are heated, they all evolve oxygen; when mixed with com-

bustibles, as sulphur, sulphide of antimony, sugar, etc., mixtures are formed which explode on the slightest concussion or friction.

Bromine (Br), atomic weight 80. This element is a dark brown liquid, it is the only non-metallic element which is liquid under ordinary conditions. Bromine occurs in nature combined with silver, AgBr, and magnesium, $MgBr_2$. Magnesium bromide occurs in sea-water.

Bromine is usually prepared from the concentrated liquid which is left when sea-water has been evaporated down and the bulk of the ordinary salt extracted. This concentrated liquid is very bitter owing to the presence of the magnesium salts, and so is called "bittern." The bromine can be extracted as follows:—Chlorine gas is passed into the bittern, when the magnesium bromide is decomposed

$$Cl_2 + MgBr_2 = MgCl_2 + Br_2.$$

The liberated bromine is extracted by shaking up the fluid with some ether. The ether dissolves out the bromine and floats on the top of the water, forming a brown layer of bromine dissolved in ether. This layer is separated from the rest of the liquid and treated with caustic potash until the brown colour disappears

$$6Br + 6KHO = \underbrace{KBrO_3}_{\text{Potassium bromate.}} + \underbrace{5KBr}_{\text{Potassium bromide.}} + 3H_2O$$

The ether is then distilled off and the residue of potassium bromate and bromide heated until no more oxygen is evolved, and the bromate has been converted into bromide. The potassium bromide is then gently heated with black oxide of manganese and sulphuric acid, when the bromine passes over as a brown vapour, which is condensed in vessels surrounded with ice.

Bromine boils about 60° Cent., and has a very choking odour, hence its name (*brōmos*, a stink), it solidifies about −22° Cent. to a lead-grey solid. In its general properties and those of its compounds bromine closely resembles chlorine. Its compounds with hydrogen and the metals are much more easily decomposed than the corresponding compounds with chlorine, but the compounds with oxygen are more stable. Thus, hydrogen bromide

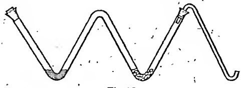


Fig. 32.

is decomposed when heated with strong sulphuric acid, so that it cannot be prepared by heating a bromide with strong sulphuric acid. The simplest method of obtaining it is to act upon moist phosphorus with bromine; a glass tube is bent into the shape of a W, Fig. 32, one end is furnished with a cork and delivery tube. In one limb is placed some bromine, in the other fragments of phosphorus and moistened glass. On warming the bromine with some hot water it rises in vapour and passes over the moist phosphorus

$$P + 5Br + 4H_2O = 5HBr + H_3PO_4.$$

The bromides closely resemble the chlorides, but are distinguished by giving off brown vapours of bromine when heated with strong sulphuric acid; the chlorides under similar circumstances evolving colourless vapours of hydrochloric acid.

The hypobromites and bromates closely resemble the corresponding chlorine bodies, and are similarly prepared.

Iodine (I), atomic weight 127, exists in minute quantities in sea-water, and is secreted by certain seaweeds, *Fucus palmatus*, etc.; when these seaweeds are burnt, the fused ash, "kelp" or "varec," contains the iodides and bromides mixed with carbonates, chlorides, sulphides, etc. This kelp is broken up and extracted with water, about ⅛th of its volume of strong sulphuric acid is added to the solution; this addition causes much effervescence owing to the escape of CO_2, H_2S, etc. Black oxide of manganese is then added to the clear solution and the mixture heated to about 60° Cent. The iodine is set free, distils over, and is collected in earthenware or glass vessels. Iodine can also be obtained from the solution by the method given under bromine. Iodine occurs in black, shining, opaque scales of almost metallic lustre, which when heated to 200° Cent. pass into a most beautiful violet gas, hence the name iodine (*iōdēs*, violet-coloured). Iodine has a peculiar smell; it is almost insoluble in pure water, one part of iodine requiring more than 5,000 parts of water, but it dissolves freely in a solution of potassium iodide; it is easily soluble in ether, chloroform, carbon bisulphide, alcohol, etc. Iodine gives a most intense dark blue colour with cold starch solution, and one part of iodine in 450,000 parts of water can thus be detected. The blue colour is destroyed by heat. Starch is insoluble in cold water, but if the milky fluid obtained by shaking starch with cold water be boiled, the starch partially dissolves.

When iodine in alcoholic solution is added to ammonia, a black powder is formed, iodide of nitrogen, NI_3, which, when dry, is fearfully explosive, a touch with a feather being sufficient to explode it. Similar explosive compounds are formed with chlorine and bromine, but these are oily liquids.

LATIN.—XXII

(Continued from p. 141.)

SUBJUNCTIVE IN SUBORDINATE SENTENCES.

§ 18. We now pass on to consider the use of the subjunctive in subordinate clauses.

It seems to be used whenever we wish not so much to make a statement as to express a thought or conception about a thing or person; whether this thought or conception be our own or someone else's. But it is often used in this way without any particular wish to give prominence to the fact that such a thought or conception is present to the mind of the person. It is thus often found where even with our attention quickened we should hardly expect it. On the other hand, the fact that the subjunctive always expresses a thought—as compared with the indicative, which simply makes the statement and leaves it as it is—enables Latin to express by it what we can only express by the constant insertion of such phrases as *as he thought*, *as he said*, *as I believe* or *consider*, etc.

It is thus always, in subordinate clauses, what has been already described as *Virtually Oblique*. It is used whenever there is a reference to one's own or somebody else's thought about what is being mentioned. And so in the sentence cited above (§ 11), Latin, by using in one case the indicative and in the other the subjunctive, is able to make the exact meaning clear at once.

Whenever, therefore, we are either obliged or wish to imply that it is our own or somebody else's thought or opinion or idea, we must use the subjunctive.

We are thus evidently always obliged to do so when we are reporting anyone's words at second hand—that is, the subjunctive is the mood regularly used in all subordinate clauses in *Oratio Obliqua*.

This usage of the subjunctive *in all subordinate sentences* in *Oratio Obliqua*, and in all cases of *Virtual Oratio Obliqua*, is the most universal and comprehensive of its general usages. We must always ask ourselves about every subordinate sentence, Is this in *Oratio Obliqua?* Is this *virtually oblique?* and if it is we must always use the subjunctive mood.

It should also be noted that there is a tendency in Latin writers to use the subjunctive in all subordinate sentences which are dependent upon a verb in the subjunctive, or, indeed, in the infinitive, the mood seeming to exercise a kind of attraction over the dependent verb.

To go more into detail we must refer to the classification of subordinate adverbial clauses given in § 10 (iii.), and try to state more precisely the usage of Latin in the particular cases.

§ 19. But first let us take at once a few relatival and causal clauses to illustrate the general difference already described between the indicative and the subjunctive.

He gave me all the things which he had. Those who have wisdom are rich. He is the man who gave me the book. I love you because you are good. He will never be willing to go away, because I shall be left behind. Virtue is the one thing which can never fail us. He said that no one was present who understood him. I promised to give him what he wanted. I refused, because they were unwilling to give me the things that I wanted. There are many who only give to others what they do not need themselves. Some men are angry because others do not praise them enough.

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§ 20. (1) FINAL CLAUSES.

Such clauses express the purpose or motive with which a thing is done, the *finis* or *end* aimed at.

In English we express this by "that" or "in order that," in combination with the auxiliary *may* or *might*, or else by the infinitive "to" or "in order to."

These are all represented in Latin by UT with the *subjunctive* (always), the tense following the usual sequence.*

Observe that the negative—English "that . . . not," "not to," "in order not to" (often = "lest," "to prevent")—is in Latin NE (not "ut non").

If there are two or more such negative final clauses together, they are co-ordinated by *neve* or *neu*, rather than by *neque*): *e.g.*—

Classem instruunt *ut* Siciliam *aggrediantur*.
They are preparing a fleet *to attack* Sicily.

Id actum est, *ut* in patrum potestate comitia *essent*.
That was done *in order that* the senate *might* be able to *control* the elections.

Consules summa ope obstabant *ne crearetur* dictator.
The consuls used all their resources *to prevent the appointment of* a dictator.

If the final clause contains an adjective or adverb in the comparative, *quo* (= *ut eo*) is used instead of *ut*: *e.g.*—

Romani sunt scriptores tibi legendi, *quo* sapientior fias (lit., *by which* you may become wiser).
You should read Latin to make yourself wiser.

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§ 21 (2) CONSECUTIVE CLAUSES.

Such clauses express the consequence or result which follows upon the statement made in the principal clause.

* Some verbs expressing desire or purpose may be followed by an infinitive if the subject is the same as the subject of the principal sentence—*e.g.*, statui hoc dicere, curo valere.

The consequence or result may be only such as would be expected to ensue; the *natural* result, as well as that which is represented as having *actually* ensued.

There is of course a broad distinction between the *actual* consequence (fact) and the natural or probable consequence (conception), and we should expect so precise a language as Latin to have marked the logical distinction by a similar distinction in expression (as, for instance, Greek uses the indicative in the former case exclusively). But it seems to have been considered that the notion of "consequence" involved some degree of conception and thought, and accordingly Latin uses in all such clauses the *subjunctive* mood only, introducing them by *ut* (negative *ut . . . non*): *e.g.*—

Classem ita validam instruxerunt ut Poenos vincerent (or vicerint, v. infra).

They prepared so strong a fleet that they conquered the Carthaginians.

Tantus fuit omnium metus ut in patrum potestate comitia essent.

So great was the panic of all that the senate were able to control the elections.

Tam potentes fuerunt consules ut nemo creatus sit dictator.

The consuls were so powerful that no one was appointed as dictator.

Nemo tam bonus est ut nunquam peccet.

No one is so good as never to do wrong.

N.B.—The tense of the subjunctive in the consecutive clause will usually be the Latin equivalent of the tense used in English. But it is sometimes difficult to decide whether the imperfect or the perfect should be used.

It must be remembered that the imperfect denotes something continuing, or commencing, or contemporaneous with a point of time in the past; the perfect denotes a simple, single fact, done once for all, or regarded as completed.

§ 22.—Before passing on to the other strictly adverbial clauses, we must note a number of cases in which Latin uses this construction of UT *with the subjunctive*.

Some of these, as will be seen, approach more closely in meaning to the *final* sense, others to the *consecutive* sense; and accordingly the negative will in the former cases be *ne*, in the latter *ut . . . non*.

Some of them again, though *adverbial* in the form of construction in Latin, are really *substantival* in meaning (in particular when the *ut* clause stands as the nominative to impersonal verbs and phrases), and can actually be interchanged with the accusative and infinitive construction. In others the substantival (*what* is done or said, etc.), and the adverbial (final or consecutive) senses seem to overlap, and we may assign them with equal correctness to either class of sentences.

It will be advantageous to the student to endeavour to decide for himself in each case to which class such sentences belong. In the case of negatives he must do so, remembering that *ne* is only used in the *final* sense.

This construction is chiefly found after verbs and phrases such as the following:—

(1) Most verbs, *imperandi* and *efficiendi*—*i.e.*, of *asking, commanding, advising, striving, effecting, entreating* (except jubeo, sino, volo, veto), and equivalent phrases such as *do operam, id ago, committo*.

(2) Impersonal phrases such as *accidit, fit, evenit, potest fieri; accedit, sequitur, restat, reliquum est, tantum abest*.

Some of the verbs *imperandi* and *efficiendi* may also be used in the sense *sentiendi* and *declarandi*, and if so used are of course followed by the accusative and infinitive. And impersonal phrases like *oportet, licet, necesse est*, are sometimes used with a subjunctive (without *ut*).

§ 23. (3) CAUSAL CLAUSES.

Such clauses express the fact which is the cause of other facts or statements, and so the verb is naturally in the *indicative* mood, unless the clause is in *Oratio Obliqua* or *Virtual Oratio Obliqua*.

The usual causal conjunctions are *quod, quia, quoniam*, which are often led up to by such particles as *idcirco, hanc ob causam, ideo*, in the principal clause.

But the relative *qui* or *quippe qui*, and *quum*, when used in a causal sense, are always followed by the *subjunctive*.

Otherwise, we see in causal clauses more clearly than in any others the difference between the indicative and the subjunctive in subordinate clauses.

§ 24. The following sentences contain examples of the different kinds of final, consecutive, and causal clauses.

Since no dry spot could be found for them to lay their wearied limbs upon, they piled up their baggage in the water and threw themselves upon it. Hannibal, that he might be raised the higher above the water, rode upon the one surviving elephant. They fought with greater vigour than in former years, because the dictator had roused the hope that the enemy might be conquered. He said that the fires were left in the part of the camp which looked towards the enemy. It chanced to happen that on that very day two slaves, who had been caught by the Carthaginians, made their escape to their masters. I pray that everything may

turn out happily. The camp was formed in such a way that the flower of the army was far away from the enemy. He sent a despatch to summon Fabius and his colleague to him to hand over to them the army. They started for Sicily to prevent the Romans bringing back the rest of the cavalry to Italy. He sent to Rome, to act as garrison of the city, the fifteen hundred soldiers whom he had with him. They advanced quickly towards the town, because it was reported that the hostages from the whole of Africa who had been given up to Scipio were being kept in the citadel there under a small garrison. The general was indignant because the soldiers were unwilling to obey his commands. He went straight to the temple that he might not be away at a time of such danger, and might not betray his ancient allies. To make him more inclined for a battle, he began to harass and annoy him. He was kept in prison to prevent him doing any mischief, so that he did not see the queen. It is impossible for me to go away, since you order me to stay. It remains for me to strongly advise you not to do so. I shall take care to persuade him not to remain any longer alone. I warn you that he will not be present.

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§ 25. (4) TEMPORAL CLAUSES.

What has just been said of causal clauses applies also to temporal clauses. The indicative is the natural mood to use, and is always actually used unless some other idea than that of time (*e.g.*, attendant circumstances or purpose) is to be expressed, or the clause is in *Oratio Obliqua* (actual or virtual), in which cases the subjunctive is employed.

But there are two temporal conjunctions (*quum* and *dum*) which are regularly, in particular cases, found with constructions peculiar to themselves, which must be carefully observed, especially as one of them is the commonest of all the temporal conjunctions.

(i.) QUUM. with the imperfect or pluperfect tense, regularly takes the SUBJUNCTIVE, *not* the indicative, mood.

If such cases are closely examined, it will probably be found that they always involve some other idea than that of mere *time* (*e.g.*, cause. contrast, concession), and that the subjunctive is used in order to give expression to this further thought. But whatever may be the explanation, there is no doubt about the usage.

There are, however, two idiomatic usages of *quum* with the Indicative even of past time—(*a*) with the *imperfect*, when both clauses denote absolutely contemporaneous time; and (*b*) in the sense of "whenever" (frequentative) of repeated acts, with the *perfect* or *pluperfect*, according as the verb of the main clause is in the present or the past.

(ii.) DUM, "during the time that," "while," when its clause refers to a period in past time during which what is related in the principal clause took place, is followed by the PRESENT TENSE of the indicative.

This construction is universal and overrides even the rules as to the use of the subjunctive in subordinate clauses in *Oratio Obliqua*.

TEMPORAL SENTENCES.

Let the student apply these rules to the translation of the following sentences:—

[*N.B.*—The chief temporal conjunctions are *quum, ubi (primum), ut, simul atque, dum, donec, priusquam, postquam;* and it will be found that one of these, especially *quum*, with the verb in the appropriate mood, will be the best way of translating many participial and other constructions of English.]

EXERCISE.

It happened ten days before you went away. I shall remain at home until you return. They said that he ought not to be sent to the army before he had appointed a consul in stead of Fabius. Even in the senate he could not obtain a hearing when bestowing eulogies upon the enemy. Minucius had been scarcely bearable before, and now he began to boast openly, as if he had already conquered Hannibal. At last, on seeing that reinforcements were being sent to the enemy also, he advanced with the legions drawn up in fighting order. Without striking a single blow, he checked the flight of his own men and the enemy's fierce onset. While learning to command, let us obey those who are wiser than ourselves. Considering that the island was by that time sufficiently protected from danger in that direction, the consul crossed over to Rhegium, because it was reported that the Carthaginian fleet was stationed there. It is reported that, after dismissing them in this state of mind, he summoned an assembly of the soldiers, and addressed them as follows. Seeing that a battle was imminent, he called them to his tent, and offered them large rewards. They reached Arretium before the general quite knew that they had started from the Po. The enemy was allowed to slip through their fingers while they wasted time in hunting through all parts of the camp. When he saw that there was no hope of conquering, he gave the signal to retreat. Scarcely had he started when his father met him. When the news of that was made public, it roused universal indignation. As soon as day broke, they unanimously, with one

accord, demanded battle. You will remain poor as long as your brother lives. Are you then waiting until he is dead?

---

§ 26. (5) CONDITIONAL CLAUSES.

It is less easy to lay down adequate rules for the usage of moods and tenses in conditional clauses in Latin. Very great variety and liberty of expression is admitted in Latin as in English, and we must be content here to note the most common and normal usages.

It is a peculiarity of the conditional statement that in it the logical and the grammatical subordination are reversed. Logically, it is the *if*-clause (the *protasis*) that is the principal clause, and the other (the *apodosis*) is dependent upon it. But grammatically the apodosis is the principal clause, and the protasis is subordinated to it, so as to qualify and limit the statement it contains; *e.g.*, "if you do this, you will do wrong" is what is called a conditional sentence (compound), in which the principal clause "you will do wrong" is limited or conditioned by the subordinate qualifying clause "if you do this."

It follows, from this grammatical subordination of the protasis, that the apodosis is the most important factor in the sentence, and that the mood of its verb will for the most part determine the mood of the verb in the protasis; the mood of the principal verb always in Latin, as we have noticed, exerting a great influence on the mood of the verbs that are grammatically subordinate to it.

If, therefore, the indicative is required in the apodosis, it must also be used in the protasis; if the subjunctive be required in the apodosis, it must also be used in the protasis.

Furthermore, it may be noted that if the indicative be required the tense of the protasis may be different from that of the apodosis, any tense that gives the sense required being admissible in either clause. But if the subjunctive be required, the tenses of the protasis and the apodosis must correspond, primary *or* secondary tenses being used in both clauses alike.

We may thus distinguish normal conditional sentences according as the verb in the apodosis is in—

(*a*) The Indicative mood (or the Imperative).
(*b*) The Subjunctive mood—primary tense.
(*c*) The Subjunctive mood—secondary tense.

Whether we use the indicative or the subjunctive will be determined by the general usage of the moods.

(*a*) If we use the indicative, we simply make the statement, treating it as though it were a fact, without entering on the question as to whether it is actually realised or not. The form of the English apodosis will be a sufficient guide to us upon this point in our translation into Latin.

(*b*) and (*c*) If we use the subjunctive, on the other hand, we treat the statement made as nothing more than an imaginary supposition, and almost imply that it will not be or has not been realised.

These imaginary suppositions, if referring to the FUTURE, are expressed by *primary* tenses (and the supposition being future may possibly be realised).

If referring to the PRESENT or PAST, they are expressed by *secondary* tenses (and it is implied that the supposition is not being or has not been realised). Latin has no means of marking the distinction of time in these suppositions, except by the insertion of *nunc* or *tum* respectively.

[*N.B.*—The subjunctive of Latin in the apodosis of these conditional clauses is represented in English by the auxiliary *should* or *would*. Wherever, therefore, *should* or *would* occurs in the apodosis of a conditional sentence in English, the sentence will belong to class (*b*) or (*c*), and the subjunctive must be used in Latin.]

The following table will show clearly the resemblances and the differences between English and Latin usage (note especially in the Indicative protasis the precision of the Latin tense :—

(*a*) Indicative—any tense:

Si hoc facio, pecco.	*If I am doing this, I am doing wrong.*
Si hoc faciam, peccabo. Si hoc fecero, peccabo.	*If I do this, I shall do wrong.*

(*b*) Subjunctive—primary tense:

Si hoc faciam, peccem.	*If I were to do this (did this), I should do wrong.*
Si hoc fecerim, peccem.	*If I should have done this (did this), I should do wrong.*

(*c*) Subjunctive—secondary tense:

Si hoc facerem, peccarem (of the present).	*If I were doing this (did this), I should be doing wrong.*
Si hoc facerem, peccarem (of the past). Si hoc fecissem, peccassem	*If I had done this, I should have done wrong.*

The conditional conjunctions in Latin are *si*; *sive*, *seu*; *dum*, *modo*; and the negatives, *nisi* or *ni*, *si non*, *sin*, *si minus*; *dum ne*, *modo ne*. [*N.B.*—*Dum* and *modo*, or *dum modo*, are always used with the SUBJUNCTIVE.]

Sive . . . *seu* ("whether . . . or") introduce alternative CONDITIONS, and must be carefully distinguished from *utrum* . . . *an*, which are interrogative conjunctions and introduce alternative QUESTIONS, and from *aut* . . . *aut*, which connect two disjunctive co-ordinate clauses.

They are used with the indicative or subjunctive just as *si* is.

The difference between *nisi* and *si non* is that the former more commonly negatives a whole clause, the latter a single word; while *sin* (which is a contraction of *si ne*, and so properly = "if not") is used in a peculiar sense = "but if," to introduce a conditional clause contrary in sense to the preceding clause.

KEY TO EXERCISES.

p. 140.

His de rebus certior factus (*the first place because these are the words that mark the connection with the preceding sentence*), Claudius Romam statim profectus est. Si me ad cenam invitabis, tecum cras veniam laetus. Eadem nocte mortui sunt duo illi liberatores patriae clarissimi. Atrox proelium cum multorum utrinque caede initum est. Summa per totum tempus hiemis quies corpora animosque (*note the precision of the Latin*) ad omnia de integro patienda renovavit. Postero die, tum segnius aggredientibus barbaris, junctae copiae (sunt), saltusque haud sine clade, majore tamen equorum quam hominum pernicie, superatus (est). Nil timet civis Romanus. Spem salutis aliam habemus nullam. Veram erga inimicos animi magnitudinem saepe praestitisse dicitur. Victos non solum occidit, sed etiam agrum ferro et igni jam vastatum occupavit. Duo servi fidelissimi cum litteris ad Agrippam missi sunt. Hoc censuit Cicero consul, privatus tamen omnino alia faciebat. Augustus ipse Marcello amisso vix consolari potuit. Drusum veniam omnibus polliciturum in Africam mittunt.

Hanno inscils Poenis, precibus aliquid se effecturum esse ratus, quum ad Flamininum noctu transisset, post quam nihil lacrimae efficiebant tristesque ut ab irato victore condiciones ferebantur, transfuga ex oratore factus apud hostem mansit.

p. 141.

Quid de me fiat? Quid dicere debui? Talia facere non ausim. Utinam ne natus umquam essem! Nil melius cupe-rem. Quid de fratre credat? Quid majus credes? Omnia tibi narrare longum est (*a peculiar idiom*). Statim id dicere melius fuit (*note both tenses*). Quicunque est, absentem illum accusare non debuerunt. Potuit facile effugere, sed conari nolebat. Hoc tam stultum facere tu audeas? Ad senectutem ne perveniam! Id votum mirandum esse credas. Falsa de his rebus te sentire affirmaverim. Totam Graeciam ne vastent hostes. Noli quemquam tuis de erroribus repre-hendere. Haec patiar senex? Nonne mihi olim sibi puero amico veniam indulgere victor potuit?

ELECTRICITY.—I.

THE ELECTRIC CURRENT — EFFECTS OF THE CURRENT — MEASUREMENT OF CURRENT — ELECTROMOTIVE FORCE — RESISTANCE — CONDUCTORS AND INSULATORS—OHM'S LAW.

INTRODUCTION.

A BRIEF explanation is necessary to justify the somewhat unusual manner in which our subject is dealt with in these lessons.

It is a time-honoured custom for writers on Elementary Electricity, to commence with a short history of the subject, and then to dwell at length on the properties possessed by glass and ebonite rods when rubbed with silk and cat's-fur, on friction and influence machines, and on every pretty or striking effect produced by statical electricity. A short space is next devoted to magnetism, primary batteries, and the laws of voltaic electricity, and then the writer enters upon a series of meagre descriptions of the applications of electricity to the industries. Special attention is too often devoted to the *curiosities* of the science instead of to the laws that govern it, and the whole is pervaded—when looked at from a modern practical standpoint—by an atmosphere of vagueness.

Few of the elementary text-books are quite free from these faults; too much space is usually devoted to statical electricity, magnetism is treated in an antiquated manner, too little space is devoted to the laws of the current, resistances, and elementary testing, and a lot of unnecessary material is usually added, giving the book the appearance of an electrical cyclopedia. To obtain real benefit from such a book, the student must at the same time attend lectures on the subject.

In the following pages statical electricity will not be dealt with till it becomes necessary to do so, and then it will be taken up as briefly as possible; quantitative information will in all cases be given in preference to qualitative, and wherever the subject allows it, an example will be given and worked out in the text.

The object of these lessons is to thoroughly instruct a beginner in the main principles of the science, giving him accurate and definite ideas on the subjects treated of, and not to initiate an enterprising schoolboy into the mysteries of how to give shocks, etc.—their object is to instruct the industrious, not to amuse the idle.

THE ELECTRIC CURRENT.

There probably is no reader who does not know that messages are transmitted from one place to another by means of what is called "an electric current" flowing through a solid wire, which is usually made of iron or copper, and stretched between the two places. No visible change takes place in the wire whilst the current is passing; in fact the closest observer would find it impossible to tell by an examination of the wire alone, whether a current was passing through it or not. We do not know what an electric current really is, but we do know for certain that *it is not a material substance* which flows through the wire from one end to the other. We also know what effects are produced on different substances when a current flows through them, and we know with considerable accuracy the laws that govern its flow.

EFFECTS OF A CURRENT.

A current produces the following three effects, by any of which its existence might be detected, and its strength measured:—

(a) *Heating effect.*—It generates a certain amount of heat in every substance through which it flows.

(b) *Chemical effect.*—A current passing through a liquid such as water, sulphuric acid, sulphate of copper, etc., decomposes it into its constituent elements.

(c) *Magnetic effect.*—A current passing through a wire deflects a suspended magnet placed in its vicinity, and keeps it deflected as long as the current flows.

All the instruments used for measuring the strength of a current depend upon the above principles, and each of them has some advantage over the others under particular circumstances.

The first question that a person naturally asks is "What strength of current is flowing through that wire?" and here we are met at the outset by the peculiar difficulty that our senses of sight, hearing, touch, etc., do not in any way help us to answer the question. Our sense of hearing allows us to form a good idea of the loudness of a sound, our sense of sight gives us fairly accurate information regarding the intensity of any light, our senses of sight or touch would enable us to form some estimate of the amount of water flowing down a stream, but when asked to form some idea of the strength of an electric current flowing through a given wire, all our senses are at fault; we must therefore fall back upon some of the current's well-known effects and trust entirely to them to supply us with an answer to the question.

It is necessary to adopt some unit for expressing the strength of a current, in the same sense that we adopt the second as the unit of time, the yard as the unit of length, etc., and the name given to the practical unit of electrical current is the ampere. In 1894 the Board of Trade defined the Ampere to be the unvarying electric current which, WHEN PASSED through a solution of NITRATE of silver, deposits at the rate of 0·001118 gramme per second. About ten amperes are usually required to run an arc-lamp; a little more than half an ampere is usually required for a 16-candle-power incandescent lamp.

We are now in a position to express the strength of a current in amperes as measured by some of the effects which it can produce. Selecting the *chemical effect*, we know from careful experiments that have been made on the subject, that if a current of one ampere flows through the following solutions for one second it will deposit the weights of metals given in the appended table:—

Name of solution.	Name of metal deposited.	Weight of metal deposited in grammes.	Weight of metal deposited in grains.
Water.	Hydrogen . .	0·00001034	0·0001595
Sulphate of copper	Copper . . .	0·0003271	0·005052
Sulphate of zinc .	Zinc . . .	0·000337	0·005199
Nitrate of silver .	Silver . . .	0·001118	0·01725

These same weights of metals would also be deposited by half an ampere flowing for two seconds, by one-tenth of an ampere flowing for ten seconds, or by ten amperes flowing for one-tenth of a second;—as long as the product of the time and the current remains the same the amount of metal deposited is unaltered; this product is known as the coulomb, so that the product of the current—expressed in amperes—by the time during which it flows—expressed in seconds—gives the number of coulombs that have passed through the solution. The weights of metals given in the above table are clearly the amounts that would be deposited by one coulomb.

EXAMPLE 1.—A steady current is passed through a solution of sulphate of copper for a period of 15 minutes, and it is found that 45·756 grains (2·9664 grammes) of pure copper have been deposited. What was the strength of the current?

The weight deposited in one second by the current is clearly 45·756 divided by the time in seconds,

$$\text{or,}\quad \frac{45\cdot756}{15\times60}=\frac{45\cdot756}{900}$$
$$=0\cdot05084\text{ grains,}$$

and this number divided by the weight of copper deposited by one ampere in one second—viz., ·005084 grains, clearly gives the strength of the current in amperes;

$$\therefore\text{ thus, }\frac{0\cdot05084}{0\cdot005052}$$
$$=10\text{ amperes (nearly). }\textit{Answer.}$$

The student will find it more convenient to have these quantities in the form of a formula, thus:—

$$C=\frac{W}{a\times t},$$

where C expresses the strength of the current in amperes.
" W " the weight of metal deposited.
" t " time in seconds during which the current has been flowing.
" a " the weight of metal deposited by one coulomb as given in the above table.

Another example will make the working of this quite clear.

EXAMPLE 2.—A current flows through a solution of nitrate of silver for half an hour, and it is found that 62·1 grains of pure silver have been deposited. What was the strength of the current?

Here $W = 62{\cdot}1$ grains.
„ $t = 30 \times 60$ seconds.
„ $a = 0{\cdot}01725$ grains.

Substituting these figures for the letters in the above formula, we get—

$$C = \frac{62{\cdot}1}{30 \times 60 \times 0{\cdot}0172}$$
$$= \frac{62{\cdot}1}{31{\cdot}05}$$
$$= 2 \text{ amperes.} \qquad \textit{Answer.}$$

In making one of these determinations practically, a number of precautions must be taken in order to insure accurate results. In depositing copper from a solution of sulphate of copper, the following would be the best mode of proceeding:—

The sulphate of copper should be a saturated solution made from pure crystals. The current should be led into and out of the liquid by means of square copper plates, of about the same size and fixed parallel to each other at a distance of about half an inch. The area of one face of each of these plates should not be less than two square inches for every ampere of current that it is proposed to pass through the solution. In the above example the plates used should be at least 20 square inches in area. If the plates are too small the copper will be deposited in a loose friable condition, and some of it will most probably drop off and fall to the bottom of the liquid; the true weight of copper deposited by the current could not then be conveniently obtained. Both plates should be perfectly clean before starting the experiment; the best method to insure their cleanliness is as follows:—Scrub them with silver-sand and water, and rinse them in pure water, then immerse them in methylated spirits, and finally pour some ether over them. The ether will quickly evaporate, leaving them perfectly dry and clean, and ready to be weighed. They must be held by the edges, as a finger-mark on their surface would leave sufficient grease there to interfere with the good working of the experiment. It is only necessary to weigh the plate by which the current is led out of the solution, as it is only on this plate that any deposit takes place. This plate therefore might with advantage be made of thin hard copper so as to have it as light as possible, and still present a large surface. The other plate might be made fairly heavy and substantial, as an exactly equal weight of copper is torn off this plate by the current as is deposited on the other.

The thin plate is now carefully weighed, and both plates having been placed in the solution as above described, the current is allowed to flow for a measured time. The thin plate is now taken out, carefully washed in pure water and methylated spirits, dried with ether, and weighed. Its increase in weight gives the amount of pure copper that has been deposited on it by the action of the current. The strength of current can then be calculated as shown in the above examples.

This method of measuring the strength of a current is very slow, and requires a good deal of careful work, but it is thoroughly reliable when the ordinary precautions are taken, and it is the method usually adopted for testing the accuracy of standard measuring instruments.

ELECTROMOTIVE FORCE.

We know from daily observation that an electric current flowing through any substance is capable of doing work; we know that when it flows through the filament of an incandescent lamp it expends energy in heating that filament to a white heat, thus rendering it capable of emitting a bright light; we know that the currents flowing through telegraph wires are able to work the instruments at the receiving stations, and by that means to transmit messages from one place to another; and similarly, any current may be made to do some useful piece of work. If, therefore, any current is capable of doing work, it is perfectly clear that that current must be driven through the wire under the action of some impelling force; that force is known as the electromotive force, and is usually denoted by the three letters E.M.F.

In order to thoroughly grasp what this E.M.F. means, let us take an analogy, and consider what happens when a pipe is opened between two reservoirs of water situated at different levels on the side of a hill. It is quite clear that the water will flow through the pipe from the reservoir at the high level down to the one at the lower level, and the reason of this flow is because the pressure due to the force of gravity drives the water from places of high to places of low level. The rate at which the water will be driven through the pipe depends upon the difference of level of the two reservoirs—the greater this difference the greater is the force impelling the water. We might call the force driving the water through the pipe the *gravitymotive force*, and in exactly the same sense we call the force which drives the electric current through a wire the *electromotive force* or the E.M.F.

The strength of the current flowing through any substance depends—other things remaining the same—upon the amount of E.M.F. driving it, ***and is exactly proportional to that*** E.M.F.; if the E.M.F is doubled the current is also doubled; if the E.M.F. is halved, the current is halved, and so on. We can express the strength of a current by saying it

is so many amperes, and in like manner we must have some unit by which we can express the exact amount of E.M.F. driving the current; the name given to that unit is the **volt**. Some idea of its amount may be formed from the following:—

The E.M.F. of an ordinary zinc and copper cell is about one volt.

It requires about 50 volts to drive the necessary current through an arc lamp.

The E.M.F. of an accumulator is about 2 volts.

The usual E.M.F. at which incandescent lamps are run is about 100 volts.

100 volts will give a distinctly unpleasant but not usually a dangerous "shock."

RESISTANCE.

Returning to the water analogy, a moment's consideration is sufficient to show us that the amount of water that flows from one reservoir to the other in a given time through the pipe depends not only upon the force that is driving it, but also *upon the nature of the pipe*. If the pipe is a short, straight, thick one, a considerable volume of water will flow through in a given time, but, on the other hand, if the pipe is long, narrow, twisted, and having a rough surface, it is quite evident that a much smaller volume of water will pass through it in the same time; in other words, the pipe through which the water flows offers a certain resistance to its passage, and the amount of this resistance entirely depends upon the nature of the pipe.

In exactly the same manner, the strength of the electric current that can be driven through a given substance depends not only upon the amount of E.M.F. driving it, but also upon the resistance in the substance through which the current is driven. There is no substance in nature that does not offer some resistance to the passage of an electric current through it. The resistances offered by different substances vary between very large limits; some substances offer resistances which are practically infinite, and through which it is therefore impossible to drive any current, no matter how great may be the E.M.F. applied;—these substances are known as *non-conductors* or *insulators*.

To this class the following substances belong:—

Porcelain.	Sulphur.
Dry Paper.	Amber.
Silk.	Shellac.
Precious Gems.	Ebonite.
Mica.	Gutta-percha.
Glass.	India-rubber.
Wax.	Dry Air, etc. etc. etc.

On the other hand, there are many substances which offer but comparatively small resistance to the passage of an electric current, and these are known as *conductors;* most of the metals belong to this class. Between these two extremes—conductors and non-conductors—there are substances offering almost every intermediate amount of resistance. It is now clear why a current will flow along a wire;—the wire is a good conductor, the surrounding air is a non-conductor, and the current being impelled by the E.M.F. naturally selects the path of least resistance, which is the wire.

We now want some unit by means of which we can express the amount of resistance offered by any substance to the passage of a current through it. This unit of resistance is called the ohm. An ohm is the resistance offered to an unvarying electric current by a column of mercury 106·3 centimetres long, 14·4521 grammes in mass, and of uniform cross section, at the temperature of melting ice. The following will give some further idea as to its dimensions:—

A copper wire 500 yards long and one-eighth of an inch in diameter has a resistance of about one ohm.

A mile of ordinary iron telegraph wire has a resistance of about 13 ohms.

The filament of an ordinary 16 candle-power incandescent lamp has a resistance when hot of about 150 ohms.

Provided the E.M.F. remains unchanged, the strength of current that will flow through any substance depends entirely upon the resistance of that substance; the greater the resistance the smaller is the current, and the smaller the resistance the greater is the current; in other words, *the current varies inversely as the resistance opposed to its flow.*

OHM'S LAW.

The connection between the current, electromotive force, and resistance was discovered by Dr. Ohm in 1827, and has since been found to be absolutely correct. The following is universally known as Ohm's Law:—**The current (in amperes) flowing through any substance is equal to the E.M.F. (in volts) divided by the resistance of the substance (in ohms).**

$$\text{Or, Current (in amperes)} = \frac{\text{E.M.F. } (\textit{in volts})}{\text{Resistance } (\textit{in ohms})}.$$

This law is usually expressed in symbols, in which case

C stands for the strength of the current in amperes;
E „ „ „ E.M.F. in volts; and
R „ „ „ resistance of the substance in ohms.

Thus Ohm's Law may be written as—

$$C = \frac{E}{R} \quad \text{I.}$$

EXAMPLE 3.—What strength of current will be sent through a wire having a resistance of 4 ohms by a battery which has an E.M.F. of 20 volts?

Here the E.M.F., or E, is 20 volts;
and the resistance, R, is 4 ohms.

Substituting these values in the above equation we get

$$C = \frac{20}{4}$$
$$= 5 \text{ amperes. } \textit{Answer.}$$

By means of this formula we can always calculate one term when we know the other two; if we know the current and the E.M.F., we can find the resistance; or if we know the current and resistance we can find the E.M.F. The formula can be written in either of the following forms without changing its meaning, and it is then rendered suitable for making the calculations just mentioned:—

It may be written as

$$R = \frac{E}{C} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \text{II.}$$

which renders it suitable for calculating the resistance when we know the E.M.F. and the current; or it may be written

$$E = C \times R \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \text{III.}$$

which renders it suitable for calculating the E.M.F. when we know the current and resistance.

EXAMPLE 4.—It is found that a battery having an E.M.F. of 24 volts is sending a current of 3 amperes through a wire. What is the resistance of the wire?

Here E is 24 volts;
and C is 3 amperes.

Substituting these values in II. we get

$$R = \frac{24}{3}$$
$$= 8 \text{ ohms. } \textit{Answer.}$$

EXAMPLE 5.—It is found that a current of 3 amperes is flowing through a wire which has a resistance of 9 ohms. What is the E.M.F. of the battery employed?

Here C 3 amperes;
and R is 9 ohms.

Substituting these values in III. we get

$$E = 3 \times 9$$
$$= 27 \text{ volts. } \textit{Answer.}$$

It is extremely seldom that the total resistance of a circuit can be represented by the resistance of a single wire; as a rule, the current is generated by a battery which itself possesses some resistance; it then flows through leading-wires to the place where it is required for use, and then flows through the substance where it is usefully employed. There are thus three separate resistances—the battery, the leading-wires, and the substance—through which the current must flow, and the total resistance opposed to the flow of the current is clearly the sum of these three resistances.

EXAMPLE 6.—A battery whose E.M.F. is 20 volts and resistance 3 ohms is used to send a current through a coil of wire having a resistance of 6 ohms; the resistance of the leading-wires is 1 ohm. What strength of current will flow round the circuit?

Here the E.M.F. = 20 volts;
and the resistance is the sum of all the resistances in the circuit, that is $3 + 1 + 6$.

Substituting these values for E and R in Ohm's law we get

$$C = \frac{20}{3 + 1 + 6}$$
$$= \frac{20}{10}$$
$$= 2 \text{ amperes. } \textit{Answer.}$$

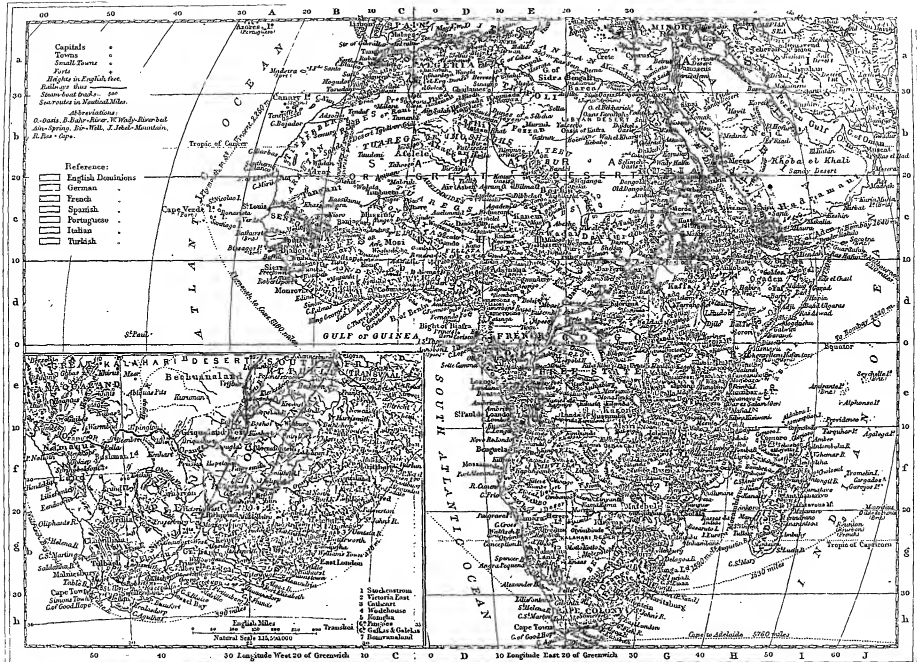
HISTORIC SKETCHES, GENERAL—II.

(*Continued from p. 138.*)

ANCIENT EGYPT.

To the historical student the history of Egypt must be especially interesting, seeing that the civilisation of Egypt was the prototype of so many of the great historical civilisations; and that Egyptian influence, Egyptian conquest, Egyptian colonies, made their impression upon the whole of the known earth. To the reader of the Bible narrative must have come many a prompting to learn more than is there given of that singular people whose history, when it touches that of the Jews, is recorded with such vivid exactness, but is barely, if at all, told when it has no reference to the chosen people. "Now there arose up a new king over Egypt, which knew not Joseph," is the only information given in the Bible concerning a whole period of history during which the country was conquered from without, and an entirely new race of people took the mastery. There was no need, if we may presume to say so, to give more information for the purposes of the Mosaic history, the object there being to contrast the treatment of Israel at one period with the treatment at another, in order to show the necessity there was for bringing them out of the land of Egypt, even with a mighty hand and a stretched-out arm. But the student may reasonably inquire what were the circumstances under which the whole policy of the Egyptians towards the Israelites became so changed; that whereas at one time a large province was allotted to the strangers, and every encouragement was given for them to live happily in the land, at another time the hand of every man was against them, and they were made to endure slavery in the country where their fathers had been princes.

Materials for an account of ancient Egypt are



English Miles

Natural Scale 1:54,000,000

London: Cassell & Company, Limited.

Geographical or Nautical Miles

F.S.Weller. F.R.G.S.

extremely few, for an historic sketch almost as scanty. The Bible furnishes by far the greatest number of serviceable links in the chain, but these are not enough to enable us to dispense with further information. Such further information has been obtained by means of traditions, by the records of other nations upon which the Egyptians set their mark, and by the histories engraven in hieroglyphics upon the walls and statues of the Egyptian palaces and tombs. By this assistance it has been possible to decide upon the *locus in quo* of many an historical event: battles, changes of dynasty, manners and customs, mode of government; and the advent of national blessings and calamities are thus chronicled. Prominent facts stand out in relief against the blank wall of time, and serve as marks by which to trace the march of the people from their origin to their historical grave.

Originally it appears that Egypt was divided into a number of small states, whereof Memphis was the most powerful. The Pharaohs, of whom Abraham heard and whom he visited, reigned there and were powerful princes, obeyed by a numerous aristocracy, and by a large and thriving population, skilled in all the arts by which nations grow rich. Whether they ever reigned over the whole country is questionable, but it is certain they commanded it either in sovereignty or by alliances, and that their word was law throughout Egypt. The people were excellent agriculturists, and seem early to have taken advantage of the river's overflow to get extra corn crops out of the ground annually inundated; they were also good mechanicians, elegant architects, and truly wonderful builders. In the sciences of mathematics and astronomy they were more learned than any of their contemporaries, except perhaps the Chinese; and their pursuits generally were those of a people more wedded to the arts of peace and civilisation than to those of war. Indeed, they appear to have been almost too indifferent to the science and practice of war, for on their borders to the south were the aggressive Ethiopians, ever ready to take advantage of the weakness or unreadiness of an enemy; and on the west were those children of the desert, the wandering shepherd tribes, who availed themselves of every opportunity to assail their wealthy and tempting neighbours.

It must not be supposed, however, that the Egyptians were altogether neglectful of the art of securing peace by preparing for war. They had a very complete and very efficient military system, and their arms, both offensive and defensive, were superior to those of all the surrounding nations; their war-horses — used for chariots rather than for cavalry purposes—were of the finest breed, and great care was taken to maintain the breed unsullied. In the use of chariots drawn by two horses, and manned by a charioteer, who drove and also protected his companion with a shield, and by a warrior, the Egyptians were specially famous. Their skill in archery was proverbial, and the exactness of their drill, and the compactness of their battalions, were subjects of universal admiration. The idea of military glory was embodied in the rule of caste, which placed the warrior second only to the priest in the social and political scale; and in the earlier and middle periods of Egyptian history this idea found practical expression in expeditions against native rival states, and against foreign foes. Excellence in peaceful arts and sciences was, up to a certain time, found to be compatible with proficiency in war; and it was not till the Egyptians, yielding to the enervating influences of luxury and of climate, reposed for their security upon the dread of their renown rather than upon present strength, that their enemies ventured to attack them.

The decline of the military power of the original Egyptians began to be marked some little time before the advent of Joseph into the country. The Hyksos, or wandering shepherd tribes, had made several successful raids from their deserts into the land of plenty; and though driven out with the strong hand, it was only by efforts which taxed the strength of the government, while the marauders carried back with them into their deserts the memory of a country rich in all the wealth of nature and art, and peopled by a race in whom the weakening influence of prosperity was beginning to develop.

It was perfectly natural, therefore, that the Egyptians, conscious of the bait they were to men who had nothing to lose and everything to gain by a war, should, with the further consciousness of their own growing inability to defend themselves, have been particularly jealous of the prying eyes of strangers. It was this jealousy which gave Joseph a pretext for feigning anger against his brethren. "Ye are spies!" "To spy out the nakedness of the land are ye come down," was the very language an Egyptian ruler might reasonably have used to strangers who had come from the dreaded country of the wanderers, and who might, impelled by hunger for "the corn in Egypt," return in numbers, and accomplish the subjection which the Egyptians were beginning to fear. The same jealousy, had no rule of caste supplemented it, would have made the Hebrews, equally with other shepherds, "an abomination unto the Egyptians," even to preventing the Egyptians from eating at the same table with them.

This dread of evil to come out of the desert was not misplaced. The natural tendency of a nomad

population, which has increased so that the wandering space at its disposal is insufficient for its wants, is to pour over the frontiers of the nearest civilisation, to wage war upon it, and finally to overcome it, or to be absorbed within it. The wise king who ruled Egypt in Joseph's time seems to have apprehended this rule, and knowing that ere long he might expect to see its application to the desert men and Egypt, took the statesmanlike precaution of offering upon the frontier a home to the best of the wanderers—men, who, besides being warlike, and able, therefore, to bear the brunt of first attacks, were intellectually and morally far in advance of their compeers, and might, as Joseph had done, "inform his princes" and "teach his senators wisdom." Hence the settlement in the land of Goshen. The Israelites emigrated *en masse* to the land that flowed with milk and honey, and the Egyptians enjoyed the benefit of their presence, both as warders against invasion from the west, and as the possessors of a civilisation hardly inferior to their own. The wisdom of the government made every provision for the encouragement of the Israelites in their new home, even causing a jealousy to spring up in the breasts of the Egyptians against them: the new-comers taught the people many new and desirable things, and the first blows of invasion fell upon them instead of upon the native population. For many years all went well with the two peoples, who lived together in unity, though, of course, in that distinctiveness which was characteristic of both of them, but especially of the Hebrews, who then, as now, were "a peculiar people," separated by indelible natural marks from all the rest of mankind. Then there "arose a Pharaoh who knew not Joseph." The Hyksos, or shepherd kings of the vast districts on the west of Egypt, gathering their forces, took an opportunity, and came upon their enemies like a thunder-clap. Vain was the interposition of the Israelites between the desired land and its assailants; vain was the military system, perfect as it was supposed to be, of the great Egyptian monarchy. The half savages of the deserts were an overmatch for the refined soldiers of the kingdom, and the old civilisation went down before the mighty onset of the invaders like chaff before the wind. The ancient dynasty of the wise Pharaohs, who had ruled equitably and striven to do right, was ended; a shepherd chief, indeed an abomination to the Egyptians, was seated on the Egyptian throne, and a rule was established at once subversive of the Israelitish and old Egyptian brotherhood. The Pharaoh who "knew not Joseph"—that is to say, who was not bound by the ties which knit Joseph's descendants (for Joseph had been dead long years before) to the Egyptians—governed tyrannically over both peoples alike, bruising both of them in pieces, like a potter's

"Ye are Spies."

vessel. The Egyptians proper, being the more numerous, and the more necessary to the conquerors, fared better than the Israelites, who were doubtless looked upon as deserters from the cause of the wandering tribes, and were punished as traitors who had made common cause with the enemy. They were particularly oppressed, they were set on labour not only derogatory in itself, but hard beyond compare, and even insulted in every possible way both as regarded their nation and religion. From having been the friends of princes they became the slaves of servants, and were forced to endure in a strange land all the miseries and indignities of the most servile peoples. Under the late rule, their religion, though regarded with jealousy and dislike by the priesthood, had been liberally tolerated, and "in the land of Goshen, where the children of Israel dwelt," had been allowed to be the prevailing faith. But now things were altogether different. With difficulty could the descendants of Abraham preserve their distinctiveness; it was almost impossible for them to worship God according to the rites which tradition bade them observe; their labour was incessant, the severity of their taskmasters was unremitting, and no amount of zeal, no amount of submissiveness, served to bring an amelioration of their condition. The new masters were insensible to pity; careless whether or not they destroyed the Israelites as a population; anxious only, while their own rule lasted, to get as much work as possible out of the wretched folk. Many of the people died under the unwonted burdens laid upon them, others took to heart the deep teaching of adversity, and acknowledging the hand of God in the afflictions which were sent upon them, chastened their minds and purified their hearts, and became gradually fitted for the great change which was thereafter to come to them under the guidance and apostleship of Moses. What that change was, how it was wrought, and the effect it had upon the whole world since that time, will be traced in the historic sketch of the Jewish nation which it is proposed to make one of the present series of papers. Enough here to know that soon after the departure of the Israelites by the mighty hand and stretched-out arm of the God of Israel, the power of the shepherd kings waned and drooped, and was ultimately overthrown by a well-planned insurrection of the Egyptians.

The people rising again from their ashes, in which had lived their "wonted fires," grew more powerful than before the conquest by the Hyksos. The King of Thebes extended his empire over all Lower Egypt, annexed the greater part of Nubia, and having driven the Hyksos into fortresses, finally compelled them to surrender, and did to the defenders according to the universal, cruel custom of the Egyptians. Although it happened that the Hyksos again made head, and, bringing in reinforcements from the desert, drove the reigning king from his throne, they never more made serious havoc with the Egyptians, and were themselves finally driven out by the aid of an Ethiopian army. Then came an era of great glory for the Egyptians. Sesostris (Rameses the Great) united all the Egyptian states under one king, and developing the resources of the land, grew mighty and flourished. His conquests extended from the extreme south of Ethiopia into Persia and Greece. Large portions of eastern Arabia acknowledged him, and it is said that he even made preparations for the conquest of India, by means of his fleets, which were built on the Red Sea, and passed out through the Straits of Bab-el-Mandeb. Men of all colours and of all nations were among his prisoners, and he had the wisdom to profit by what his enemies could teach him, and to establish at home the arts and manufactures which his captives knew. Although uncertain, it appears probable, that the conquests of Sesostris, extending to Syria and Palestine, took place during the wanderings of the Israelites in the desert; and if so, by weakening native princes whose territories were not retained, must materially have assisted their occupation of the promised land.

After Sesostris came many weak princes, relieved now and again by the presence of some strong men; but for three hundred years after the death of the great conqueror little is known of Egyptian history, the Scripture record making scarcely any mention of it. About a thousand years before Christ, Shishak King of Egypt made war upon Palestine, and was one of the first scourges sent by the Almighty upon Israel to bring them back to a knowledge of Him whom they so systematically deserted; but the power of Egypt was broken by many distant expeditions, and after Shishak's reign declined rapidly. The throne was accessible to whoever was strong and bold enough to seize it—even strangers occupied it; and the manifest weakness of the once mighty empire attracted the greedy attention of those who were on the look-out for conquests. In the year 713 B.C., Sennacherib King of Assyria, then one of the mightiest princes on the earth, invaded Egypt with an army which, but for a pestilence which struck down thousands of the troops, must easily have conquered the whole land; but the sickness was such that the Assyrian army had to turn back, and going up to Jerusalem died there. After this the Egyptians as a nation may be said to have become extinct, so large was the admixture of foreign blood and foreign institutions. Soldiers were brought in from without and men of

no known country became kings. Some of the kings—Pharaoh-Necho, for example, B.C. 616—infused the energy and strong will of a new man into the administration, and for a while caused Egypt to shine forth with even more than pristine splendour. His fleets scoured the Mediterranean and Red Seas, and pushed into Indian waters; and it is asserted that an expedition, fitted out at his cost, sailed down the east coast of Africa, discovered and rounded the Cape of Good Hope, and returned home after an absence of three years, by way of the Atlantic and the Straits of Gibraltar.

But Egypt had had its day as an empire, and was doomed to fall under the advance of newer civilisations. Cyrus the Persian struck the first great blow at her, and Cambyses, his son and successor, effected her subjugation, put all her chief nobles to an ignominious death, and compelled her wretched king to drink poison. The Persians, who had a religious hatred as well as the contempt of conquerors for the Egyptians, oppressed the people almost worse than the Egyptians had done by the Hebrews many centuries before. The temples were defiled, the sacred animals were slain and eaten, and the priests of Egypt—hateful to the Persians, who detested all priests whatever—were made to bear almost unendurable oppression. The history of Egypt, therefore, during the whole period of the Persian occupation, is a record of constant desperate rebellions, fiercely and pitilessly repressed; and this state of things continued until the overthrow of the Persian power in Asia by Alexander the Great. Upon his death the empire he had founded fell quickly to pieces, and the several members of his dominions came into the hands of whoever could seize them. Egypt once more passed under native rule, and became again famous in history under the Ptolemies, whose line, ending in Cleopatra, lasted two hundred years, and then succumbed to the overshadowing power of the Romans. In the year 30 B.C., and under the auspices of Augustus Cæsar, Egypt became a Roman province. What part she played in after-history—how she was the seat of one of the chief Christian churches—how monachism began there—how Christians devoid of the spirit of Christ behaved unchristianly, and becoming unworthy were swept away by the tide of Saracenic conquest—how Saracens yielded in the end to Turks—all these things are matters of history; but the limits proposed for the present subject do not allow of extension of treatment, and the sketch remains, therefore, essentially one of the history of purely Ancient Egypt.

See:—Ebers's Egypt; Cassell's Universal History.

COMMERCIAL BOTANY OF THE NINETEENTH CENTURY.—X.

[*Continued from p.* 151.]

GUMS, RESINS, AND VARNISHES.

THE points of interest connected with these substances lie most in the clearing up of doubts relating to their botanical origin and their accurate determination as well as in their increased consumption and imports. The former, however interesting though it be, does not come within the scope of these lessons, except where it bears on the development of the substance from a commercial point of view, or is instrumental in opening up new sources of supply. Under these circumstances our notes in this section will be necessarily limited. In passing, however, it may perhaps be of some interest to note that of gum arabic, which may be taken as the most important of the true gums; the imports have increased from 25,289 cwt. in 1839 to 75,399 cwt. in 1886, falling again in 1887 to 46,443 cwt., a decrease due to the disturbed state of the country whence the best kind of gum is obtained, and rising again in 1897 to 63,208 cwts. In consequence of this higher prices have ruled the market, and other gums have been brought into competition, the most notable of which is that which appeared early in 1888, under the name of Brazilian gum arabic. In appearance it resembles the ordinary quality of gum arabic, and is said to be derived from the Angico tree of Brazil. It is referred to in the *Kew Bulletin*, No. 17, for May, 1888, as *Acacia angico*, but since then the plant has been described as *Piptadenia macrocarpa*. The fragrant gum-resins, known as Balsams of Peru and Tolu, were, fifty years ago, considered to be the produce of the same tree, Tolu being the resin hardened by exposure. It has been known now for some time that Balsam of Peru is the produce of *Myroxylon Pereiræ*, a native of Salvador, in Central America, while Balsam of Tolu is furnished by *Myroxylon toluiferum*, of Venezuela and New Grenada.

Under the trade names of ANIMI or COPAL several kinds of hard fossil resin have long been known in commerce, partly derived from Africa and partly from the East. The sources of these gums, which were then, as now, used exclusively in the manufacture of varnishes, were for a long time quite unknown. Indeed, the most valuable resin, namely, that known as Anime, was, until comparatively recent times, supposed to be the produce of India, being shipped to this country from Bombay. It is, however, now known to be furnished by *Trachylobium*

Hornemannianum, a leguminous tree of Zanzibar, the resin being shipped thence to Bombay, and from Bombay to England. The clearing up of this interesting subject in economic botany is due to Sir John Kirk, British Resident at Zanzibar, who communicated a paper on the subject to the Linnean Society in 1868, and sent full herbarium specimens of the plant to Kew, as well as a fine series of gum specimens. Seeds of the tree have since then been introduced into India and Australia.

The best anime is that which is dug from the ground near the roots of the trees, or where the trees once stood but have now disappeared. Regarding the export of anime from Zanzibar, Sir John Kirk says it sometimes reaches 800,000 pounds, of the value of £60,000.

What promised to be a very important source of copal was made known in 1883, when the British Consul at Mozambique reported the discovery at Inhambane of a tract of copal forest fully 200 miles long. Samples of this new fossil copal or Anime were sent to England, and upon practical tests being made upon its suitability for varnish-making, was favourably reported on, and valued at from £80 to £100 per ton. Some of these samples are now contained in the Museum at Kew. It is the produce of *Copaifera Gorskiana*.

Some later information on the subject is given in the *Kew Bulletin*, No. 24, for December, 1888, where there is an extract from a letter from Inhambane, under date Feb. 5, 1886, in which the writer states:—"Many tons of copal have been exported from Inhambane. For some choice pieces I have received as high as £13 10s. per cwt. The average price realised on larger lots has been £7 per cwt. The forest containing the trees extends from the River Sabia in a south-westerly direction as far as Beleni.".

Fresh seeds of the plant were also received at Kew, and several hundred plants raised from them, which have been distributed from Kew to India, Fiji, Singapore, Jamaica, Trinidad, Demerara, Dominica, and tropical parts of Australia, but no further information has been received of them.

Another varnish-making resin is Kauri or Cowdie resin of New Zealand. This, like anime, is a semi-fossil resin, more commonly known in trade, however, under the name of Kauri Gum, and is the produce of *Agathis australis*, a very large coniferous tree valued alike for its timber as for its gum (*see* Timbers). The best Kauri gum is dug from the ground beneath the trees, or where the trees do not at present exist. Thirty-three years ago Kauri-gum was imported into this country only in small quantities, for we find that in 1853 the total exports of the gum from New Zealand to all countries amounted to only 829 tons, of the value of £15,971; in 1883 this had risen to 6,518 tons, valued at £336,606. It is said that over two-thirds of the produce goes to the United States; and there are no available returns of the imports into this country, though the quantities are very large. Though gum-digging gives employment to a large number of persons, they generally consist of the lowest classes. Of recent years, however, it has been stated that in consequence of depression of trade in New Zealand, a large number of men have taken to Kauri digging, as many as 10,000 being so occupied at present, and the quantity of gum brought to the Auckland market has very considerably increased.

Under the name of OGEA GUM, a hard fossil resin of the copal character was introduced to notice in 1883 by Captain (now Sir Alfred) Moloney from the Gold Coast. It is described as being the produce of a leguminous tree closely allied to *Daniellia thurifera;* for lack of proper material, however, its species has not yet been determined. The gum is used by the natives both for lighting fires and for illuminating purposes; powdered, it is also used as a body perfume by the women. It exudes from the trunk either from wounds or from holes caused by the boring of insects. The gum has not yet appeared in commerce.

DYES AND TANNING MATERIALS.

The greatest development in the direction of dyes during the present century has not been towards those of vegetable origin. On the contrary, for the last twenty or thirty years vegetable dyes have been rapidly displaced by the advances of chemical science in utilising coal tar, and in the artificial preparation of colouring matters to supersede the old vegetable dyes. In this direction we need but refer to the serious blow given to the trade in Persian berries (*Rhamnus infectorius*) in the Levant by the discovery of the Aniline dyes, or to the more recent substitution of chemically prepared indigo for that of vegetable origin. So alarming did this discovery seem to be to the indigo-planters in India that we cannot refrain from quoting the following paragraph from a letter of Professor Armstrong published in the Kew Report for 1880. He says:—"Notwithstanding the number of operations involved in the manufacture, it is stated that it will be possible thus to produce indigo at such a price that it can even enter into competition with the natural article, and that by substituting the method of dyeing previously described for the troublesome and somewhat uncertain indigo vat method, there will be a still more distinct advantage gained over the natural article. It is difficult at present to

estimate the influence which this discovery may have on the production of indigo in India, but when it is remembered, to take an analogous case, that the discovery of a process of manufacturing madder red was only made in 1869, and that now it is almost impossible to procure natural madder red or garancine, the annual value of the imports of which into the United Kingdom alone for the years 1859 to 1868 amounted to about £1,000,000 sterling, it is difficult to avoid the conclusion that artificial indigo will most seriously interfere with, even if it does not within a very few years altogether displace, the natural article."

Though this was written eighteen years ago, vegetable indigo still retains a position in the market, though artificial indigo is gradually making its way. In 1894 the attention of the Kew authorities was drawn to the fact that the ripe fruits of the clove tree, known as Mother Cloves (*Eugenia caryophyllata*), were used in Seychelles for dyeing cloth. Though not an entirely new use for the product, it was considered of sufficient importance for the colouring matter to be investigated, which was done at the Yorkshire College, Leeds, resulting, however, with but little prospect of its commercial value. (See *Kew Bulletin*, 1894, p. 417).

Another singular dye plant has been brought to notice in the *Kew Bulletin* for 1895, p. 230, and 1896, p. 74. It is the produce of a Chinese yam (*Dioscorea rhipogonoides*), and is known as SHU-LANG ROOT. It seems to be extensively used at Rakhoi in dyeing coarse native cotton cloth and fishing nets a dark brown or tan colour.

Under the name of KAO ASHUD, the roots of *Geranium wallichianum* were introduced to notice in 1895 as a dye product. The plant is a native of temperate Himalaya, and the roots are said to be largely used as a dye stuff in Kashmir. They were examined at the Yorkshire College, Leeds, to test their value either for dyeing or tanning purposes. For the former it would appear to be of no great promise; but for the latter it is stated in the *Kew Bulletin*, 1896, pp. 29–31, that "there seems no reason why, if the material can be obtained in sufficient quantities, it should not form a valuable addition to our tanning materials."

ZALIL (*Delphinium Zalil*). Under this name an interesting account is given in the *Kew Bulletin* for 1889, p. 111, where it is said that the flowers are collected largely in Afghanistan for exportation chiefly to Persia for dyeing silk; they are also exported from Herat, through Afghanistan, to northern India, to be employed as a dye, as well as to be used in medicine. A further interesting note on this dye will be found in the *Kew Bulletin* for 1895, p. 167.

The hard dried fruits now imported from India in such large quantities under the name of MYROBALANS were only just appearing in commerce when her Majesty ascended the throne; at the present time they come into this country from India for the use of tanners, to the extent of about 540,000 cwt. a year. Two kinds are known in commerce — the CHEBULIC MYROBALAN (*Terminalia chebula*) and the BELLERIC MYROBALAN (*T. belerica*).

In 1875 the pods of a leguminous tree of South America (*Cæsalpinia brevifolia*) were introduced from Santiago under the name of ALGAROBA. They were said, at the time, to contain a large amount of tannin—90 per cent.—and to be superior even to DIVI-DIVI (*Cæsalpinia coriaria*). In 1878 some pods of *Wagatea spicata* were sent from India to test their value for tanning purposes. They were said to contain 15 per cent. of tannic acid. The plant is a native of the Concan, and is a scrambling thorny shrub belonging to the natural order Leguminosæ. Seeds of this plant were distributed from Kew to Demerara, Dominica, Jamaica, Trinidad, and other places.

Elephantorrhiza Burchellii. Under the name of ELANDS BONTJES, the root bark of this leguminous plant first attracted attention in 1866, when a paper was read before the Pharmaceutical Society by Professor Attfield and published in the *Pharmaceutical Journal*, Vol. 8, 2nd Series, p. 316. The plant, which was there referred to as a species of *Acacia*, is said to furnish food from its seeds, a medicinal infusion from its root, and also a valuable tanning material. It was found upon analysis to contain 20 per cent. of tannic acid. Nothing further was heard of this root till 1886, when it was exhibited in the Natal Court of the Colonial and Indian Exhibition. Mr. T. Christy, in his *New Commercial Plants and Drugs*, No. 10, published in 1887, says:—"Mr. W. N. Evans, who tested the root, states that it contains 25·37 per cent. of tannin, and that if it were to work up in a similar manner to Mimosa bark, the best samples might be worth from £14 to £15 per ton. With regard to its practical value as a tanning material for leather from the incomplete trials that were made with the small quantity received, it was found to give too red a colour, but I should not like to speak positively upon this point, as in treating a few hundredweights of the roots at a time it might be found that this detriment could be overcome."

Phyllocladus trichomanoides. A very large coniferous tree of New Zealand, where it is known as TANEKAHA. The bark, which is of an orange-

yellow colour, has of late years come largely into use in this country for dyeing kid or dogskin gloves.

Under the name of WATTLE bark, the barks of several species of *Acacia* have been brought from Australia for some years past for tanning purposes. They are sometimes known as MIMOSA barks, and are said to be nearly or quite as strong as Valonia, giving a hard and heavy leather but of a dark colour. The principal species which furnish the barks are the Broad-leaved Wattle (*Acacia pycnantha*), the Black Wattle (*A. decurrens*, var. *mollissima*), and the Silver Wattle (*A. dealbata*).

A tanning material known as CANAIGRE has been used in America for some years past; and accounts of it have appeared from time to time in this country. In the *Leather Trades' Circular* for August 8th, 1885, under the head of "New Tanning Agents," the following appeared:—"An Arizona paper states that a new tanning agent, likely to be of great value, has been discovered, one which also has the property of adding weight to the leather. The plant is an annual, and grows upon desert and dry upland soil. It is known by the Mexicans and Indians as GONAGRA. . . . Practical use demonstrated that the tanning properties of this root were about three times as great as the Common Oak bark, and that in all essentials it was superior to the bark in the manufacture of leather." The roots, which are fleshy, are from three to six inches long and one and half to three inches broad, of a somewhat oval shape, and covered with a dark brown skin. The stems and leaves are described as being acid like rhubarb, and are used in a similar way in California and Utah under the name of WILD PIE plants. In Texas the roots are used for tanning. The plant is *Rumex hymenosepalus*, belonging to the natural order *Polygonaceæ*, and from an analysis made in 1890 the roots promised to be a valuable addition to our list of tanning substances. This interesting substance is fully detailed in the *Kew Bulletin* for 1893, p. 63, 1894, p. 167, and 1897, p. 200.

TENGAH BARK (*Ceriops candolleana*). This bark was brought to notice in the *Kew Bulletin* for 1897, p. 91. It is a common tree at Singapore, and is allied to the tropical Mangroves. At Singapore the bark is used both for dyeing and tanning, producing a brownish red, a good black or purple. The report on a sample of Tengah bark extract submitted for examination to the Yorkshire College, Leeds, was that it "behaves, as regards its dyeing properties, in a similar manner to a good quality Catechu," and that it would certainly be of value to dyers.

PAPER MATERIALS.

The enormous demand for paper that has sprung up of late years has, like the demand for so many other products, caused those most interested to divert their attention to new sources of material It was in 1856 that the late Mr. Thomas Routledge obtained a patent for manufacturing paper from Esparto grass. In that year the total imports of Esparto amounted to only 50 tons, while in 1897 204,579 tons of vegetable fibres were imported for paper-making. Another substance to the utilisation of which Mr. Routledge paid considerable attention was the young stems of bamboos, and he succeeded in showing that a very fine paper could be made from these stems, as he published a pamphlet on the subject in 1875 which was printed on paper made from bamboo. The interest in the project to utilise the bamboos as a paper material became general, both in England, India, and America. One thing to be borne in mind in considering this subject is that the several species of *Bambusa* and *Dendrocalamus* are equally suited to the manufacture of paper, and that in India bamboos are very plentiful. Notwithstanding the interest taken in the Bamboo as a probable source of paper material, it has not, down to the present time, become a recognised article of trade.

BAOBAB (*Adansonia digitata*). The fibrous bark of this well-known West African tree was first brought to the notice of the paper-maker in 1876. It was proved upon trial to possess all the necessary properties for making an excellent paper. The drawback to its general utilisation has been the slow growth both of tree and bark, and the probability of a failure in the supply.

PAPER MULBERRY (*Broussonetia papyrifera*). This well-known tree, from the bark of which the Polynesian islanders make their Tapa cloths, and the Japanese a large portion of their excellent paper, was first brought to the notice of English paper-makers in 1879.

CALIFORNIAN "CACTUS." Under this name the stems of a plant were brought to the notice of the Kew authorities in 1877 as a valuable paper material. It was difficult, from the material first brought, to determine its botanical affinity. In 1878, however, further material came to hand, from which the plant turned out to be *Yucca brevifolia*, described in California previously, but incorrectly, as *Yucca Draconis*. Forests of this plant existed in the Mohave desert for several miles, through which the Southern Pacific Railway runs. The stem of the plant, which grows to a diameter of a foot or more, is of a very fibrous character, and it was soon found to be an excellent paper material, in consequence of which the plants have been systematically cut down and turned into paper, which was at one time used almost, if not quite,

exclusively for printing the *Daily Telegraph* upon.

Cavanillesia platanifolia. A plant belonging to the Malvaceæ, found abundantly in the eastern part of the State of Panama, and as far east as Carthagena, known as YOLANDERO. The fibrous bark was found to pulp well, bleach readily, and to make a strong opaque white paper of fine quality. This was tested in 1877.

Uniola virgata. A grass locally abundant in Jamaica. In consequence of its bulky nature it would not pay to send it in its raw state to England, but it might be exported in the form of paper stock and form a somewhat inferior substitute for Esparto. It was tested in 1876.

Calotropis gigantea. Under the name of MUDAR this asclepiadaceous plant is well known in India, where the fibre from its stems is used in making cordage, and the floss from the seeds for stuffing cushions, and occasionally for weaving. It was first proposed as a paper material in 1877, but the trials made with it were not satisfactory. Again in 1880 it was spoken of favourably from India, but it has still not been received favourably in this country.

Ischæmum angustifolium. This is the BABAR or BABOI Grass of India, and grows abundantly in many parts of the country. It has long been used in India for making into ropes and cordage, and has latterly become one of the principal paper materials, being largely used in the Bally Paper Mills near Calcutta. It was introduced to notice in England in 1878, and Mr. Routledge reported upon it as follows:—"A small quantity of bleach brings it up to a good colour. The ultimate fibre is very fine and delicate, rather more so than esparto, and of about the same strength; the yield, however, is 42 per cent., somewhat less. I think I may venture to say it will make a quality of paper equal to esparto."

The great drawback to the general utilisation of the fibre in this country is that the plant has to be collected in India over wide and distant areas, and its bulky nature increases the cost of freight. It might, however, be converted into paper stock in India and exported in that form. That the plant is capable of extended cultivation in India if a demand for it should spring up in this country, has been shown in an account of its culture published in the *Proceedings of the Agricultural and Horticultural Society of India* for October, 1887. The plant is, perhaps, equally well known under the names of *Eriophorum comosum* and *Pollinia eriopoda*, under both of which it has been described.

Molinia cærulea. This well-known British grass was brought to notice as a probable source of paper material in 1878, and in the Kew Report for 1879 it is stated:—"Mr. N. G. Richardson, of Tyaquin, county Galway, has actively promoted its experimental cultivation in the west of Ireland. At a private meeting held at Athenry a committee was formed to raise subscriptions to plant ten Irish acres of bog with it at Tyaquin. Mr. W. Smith, of Golden Bridge Mills, had manufactured paper from this grass with which he was so well satisfied that 'he was prepared to buy 1,000 tons if anyone would supply him.'"

Secale cereale, RYE STRAW, was proposed in 1879, Mr. Routledge's report being that "it is very largely used in the States, also on the Continent. It will make a harder and firmer paper than any other cereal straw, except, perhaps, maize."

Musa spp. The utilisation of Plantain and Banana stems for paper-making was brought forward in the Kew Report for 1881. It is there pointed out that there can be no question as to the suitability of the fibre for the purpose, but that the practical difficulty has been in dealing with the 90 per cent. of water which the stems contain. By mechanical treatment, however, the fibre of a plantain stem can be dried off within a period of eight hours, and as the plants are very abundant in India and Burmah, it might be worth while to systematically extract the fibre for paper-making. Dr. King, of Calcutta, reporting on this subject, says:—"In my opinion this proposed plantain industry has a good deal of promise about it, and I think it might be well worth while for Government to spend a little money in sending a sufficiently large shipment to the London market, and to allow it to be sold for what it will fetch in small lots, so that the new material may become generally known to the paper-making interest. If the fibre answers for paper, Government need do no more, the matter will, no doubt, be taken up by private enterprise.

"The Bengal Government will be prepared to give all reasonable assistance to any mercantile firm or individual wishing to try experiments, and will arrange for future supplies at reasonable rates. It will also give such other assistance as may be deemed necessary and proper."

Commenting on this, Sir Joseph Hooker says:—"Whatever the success of the enterprise in India, I think the matter is well worth attention in the West Indies."

WOOD PULP.—The reduction of the trunks of certain coniferous trees, as well as of the Poplar, in the preparation of wood pulp is a well-known industry of Norway and Sweden, where factories for this purpose are still increasing, and whence a large portion of the product finds its way to this country. This industry has now assumed very large proportions.

FRENCH.—XXII.

[Continued from p. 179.]

DEMONSTRATIVE PRONOUNS.

THE demonstrative pronouns, which are so named because they serve to point out the person or thing spoken of, are classified in the following table :—

Singular.			*Plural.*		
Masc.	*Fem.*		*Masc.*	*Fem.*	
celui,	celle,	*this, that.*	ceux,	celles,	*these, those.*
celui-ci,	celle-ci,	*this.*	ceux-ci,	celles-ci,	*these.*
celui-là,	celle-là,	*that.*	ceux-là,	celles-là,	*those.*

ce, *it, they.*

Absolute Demonstrative Pronouns.

ceci, *this,* } not used in the
cela, *that,* } plural.

REMARKS ON THE DEMONSTRATIVE PRONOUNS.

The demonstrative pronouns *celui, celle.*, etc., assume the gender and number of the nouns which they represent :—

Je ne connais d'avarice permise que *celle* du temps. STANISLAS LECZINSKY.	*Methinks no avarice is allowable unless it be that of time.*
Les seules louanges que le cœur donne, sont *celles* que la bonté s'attire. MASSILLON.	*The only praises which the heart gives are those which goodness deserves.*

These pronouns are sometimes used absolutely before *qui, que, dont*, etc., in the same manner as the English personal pronouns, *he, they*, etc., before *who, whom*, etc. :—

Celui qui rend un service doit l'oublier, *celui qui* le reçoit, s'en souvenir. BARTHÉLEMY.	*He who renders a service should forget it ; he who receives it should remember it.*
Aimer *ceux qui* vous haïssent, *ceux qui* vous persécutent, c'est la charité du chrétien ; c'est l'esprit de la religion. BOURDALOUE.	*To love those who hate you, those who persecute you, is the charity of the Christian ; it is the spirit of religion.*

Celui-ci, celle-ci, etc., *celui-là, celle-là*, are used when it is desirable to denote the comparative proximity or remoteness expressed in English by the words *this* and *that* :—

celui-ci, *this one.* celui-là, *that one.*

Celui-ci, celui-là, etc., are often used to express contrast or comparison. They are then equivalent to the English expressions, *the former, the latter ; this one, that one* :—

Un magistrat intègre et un brave officier sont également estimables ; *celui-là* fait la guerre aux ennemis domestiques, *celui-ci* nous protège contre les ennemis extérieurs. GIRAULT-DUVIVIER.	*An upright magistrate and a brave officer are equally estimable ; the former makes war against domestic enemies, the latter protects us against foreign enemies.*
Tel est l'avantage ordinaire Qu'ont sur la beauté les talents : *Ceux-ci* plaisent dans tous les temps : *Celle-là* n'a qu'un temps pour plaire. VOLTAIRE.	*Such is the ordinary advantage which talents possess over beauty ; the former please at all times, the latter has but one time to please.*

Ceci, cela, have no plural, and are used only of things. They do not refer to a word expressed before, but serve to point out objects :—

Prenez *ceci*, *take this.* Donnez-moi *cela*, *give me that.*

J'ai déjà dit ce qu'il faut faire, quand un enfant veut avoir *ceci* et *cela*. J. J. ROUSSEAU.	*I have already said what should be done when a child will have this and that.*

Ce, a pronoun, must not be confounded with the demonstrative adjective *ce*. The pronoun *ce* is often used without an antecedent, as the nominative of the verb *être*, in the same manner as the English pronoun *it* :—

C'est moi *it is I.* C'est vous, *it is you.*

Ce n'est plus le jouet d'une flamme servile.	*It is no longer the sport of an unworthy love.*
C'est Pyrrhus, c'est le fils et le rival d'Achille. RACINE.	*It is Pyrrhus ; it is the son and the rival of Achilles.*

RELATIVE PRONOUNS.

The relative pronouns are so named on account of the intimate relation which they have to a noun or pronoun which precedes, and of which they recall the idea. The noun or pronoun so preceding the relative pronoun is called the antecedent.

TABLE OF THE RELATIVE PRONOUNS.

qui, *who, which, that* (subject) dequi, *of, from whom*, } Régime indirect, genitive and ablative.
que, *whom, which, that* (direct object) dont, *of, from whom, which*, }
à qui, *to whom* (indirect object, dative)
lequel, *who, which* (composed of the article and *quel*).

Singular.		*Plural.*		
Masc.	*Fem.*	*Masc.*	*Fem.*	
lequel,	laquelle,	lesquels,	lesquelles,	*who, which.*
duquel,	de laquelle,	desquels,	desquelles,	*of, from which.*
auquel,	à laquelle,	auxquels,	auxquelles,	*to which.*

y, *to him, to her, to it, to them*, etc.
en, *of him, of her, of it, of them*, etc.
quoi, *what, which, why*, etc.
où, *in which, therein, through which*, etc.

REMARKS ON THE RELATIVE PRONOUNS.

Qui, who, which, is used as subject for both genders and numbers, for persons and for things.

When used for things, *qui* cannot be preceded by a preposition, but it can be so used in reference to persons.

It is used relatively and absolutely.

It is used relatively when it has an antecedent from which it must not be separated by a noun :—

Le premier *qui* fut roi, fut un père adoré. AUBERT.	*The first who became king, was an adored father.*
L'amour avidement croit tout ce *qui* le flatte. RACINE.	*Love believes eagerly all that flatters it.*
L'homme *en qui* vous mettez votre confiance.	*The man in whom you place your confidence.*

It may be used absolutely—*i.e.*, without an antecedent—in affirmative, negative, or interrogative sentences, and in this case as subject, and as direct or indirect object, *but only in reference to persons.* It is then rendered in English by, *he who, he whom, him who, him whom, whoever, whomsoever, who, whom* :—

Qui veut parler sur tout, souvent parle au hasard. ANDRIEUX.	*Who (he who) wishes to speak on every subject, speaks often at random.*
Je sais *de qui* elle veut parler.	*I know of whom she wishes to speak.*
Elle épousera *qui* elle voudra.	*She shall marry whomsoever she likes.*
À qui écrivez-vous?	*To whom are you writing?*
Il sait *à qui* vous écrivez.	*He knows to whom you write.*

Qui parle? *who speaks?* *Qui* voyez-vous? *whom do you see?*

Que, whom, what, which, stands generally as direct object. This pronoun is used for persons and things. It is of both genders and numbers:—

Les lettres *que* j'ai,	*The letters which I have.*
Les hommes *que* j'ai vus,	*The men whom I have seen.*

It is relative when it has an antecedent, from which it must not be separated:—

La gloire prête un charme aux horreurs *qu'on* affronte. DELAVIGNE.	*Glory lends a charm to the horrors which we face.*
Des lois *que* nous suivons, la première est l'honneur. VOLTAIRE.	*Of the laws which we follow, the first is honour.*

It is absolute when it has no antecedent. In this sense it is only used in reference to inanimate objects, and means *what thing? what?*

Que voulez-vous?	*What will you (have)?*
Que dit-on?	*What do people say?*

Quoi, what, is invariable, and said only of things. It may be used absolutely and relatively, with or without preposition:—

J'ignore *ce à quoi* il pense *I am ignorant of what he thinks.*

In the above sentence it is relative, being preceded by its antecedent *ce*.

Il ne sait *quoi* dire. *He does not know what to say.*

Quoi, when absolute, means *what thing?* and is used mostly in interrogative and doubtful sentences:—

Il y a dans cette affaire je ne sais *quoi*, que je n'entends pas. L'ACADÉMIE.	*There is in that affair I know not what, which I do not understand.*
Il y avait je ne *sais quoi* dans ses yeux perçants, qui me faisait peur. FÉNELON.	*There was I know not what in his piercing eyes, which inspired me with fear.*

Dont, of whom, of which, whose, is used for both genders and numbers, for persons and for things. It is always employed relatively, and, therefore, always refers to an antecedent:—

Un plaisir *dont* on est assuré de se repentir ne peut jamais être tranquille. MME. DE LA VALLIÈRE.	*A pleasure of which we are sure to repent can never be a peaceful one.*
Il faut plaindre le sort du prince infortuné, *dont* le cœur endurci n'a jamais pardonné. CHÉNIER.	*We must pity the fate of that unfortunate prince, whose hardened heart has never forgiven.*

Dont is used instead of *de qui, of whom; par lequel, through which; duquel, of which; de quoi, of what,* etc., and may be separated from its antecedent:—

La dame à qui vous parliez, et *dont* vous avez vu le mari hier . . .	*The lady to whom you were speaking, and whose husband you saw yesterday . . .*

An interrogative sentence cannot be introduced by *dont*. When *whose* introduces an interrogative sentence, it is expressed in French by *de qui*, and, when absolute possession is meant, by *à qui*:—

Whose son is he?	*De qui* est-il fils?
Whose house is that?	*À qui* est cette maison?

Lequel, lesquels, laquelle, lesquelles, who, which, should be used instead of *qui* or *que*, when the latter should be separated from their antecedent by a noun, in order to avoid ambiguity. They may relate to persons or things:—

C'est un effet de la divine Providence, *lequel* attire l'admiration de tout le monde. BUSSI-RABUTIN.	*It is a provision of divine Providence, which (provision) attracts the admiration of everyone.*

Lequel, preceded by a preposition (that is, *duquel, auquel, dans lequel,* etc.), must always be used in reference to inanimate objects, and never *qui*, as has been mentioned above:—

Un livre curieux serait celui *dans lequel* on ne trouverait pas un mensonge. NAPOLÉON.	*That would be a curious book in which not a falsehood were found.*
La Seine, dans le lit *de laquelle* viennent se jeter l'Yonne, la Marne et l'Oise.	*The Seine, into the bed of which the Yonne, the Marne, and the Oise empty themselves.*

Lequel, in all its modifications, may be used in reference to persons and things:—

Lequel? *which one?*	Duquel? *of which one?*
Lequel voyez-vous?	*Which one do you see?*
C'est une de ses sœurs, mais je ne sais pas *laquelle*.	*It is one of his sisters, but I do not know which.*
Voici deux romans, choisis *lequel* tu voudras.	*Here are two novels, choose which you please.*

En, of him, of her, of it, of them. This pronoun is of both genders and numbers. It is often used for the English words *some, any,* when employed absolutely, or even when understood, as indirect object in relation to things, and sometimes, but not often, in relation to persons, instead of the personal pronouns *de lui, d'elle, d'eux, d'elles.* This pronoun must be placed before the verb when the latter is followed by a numeral adjective, an adverb of quantity, or a noun of quantity, whenever those words are not followed by a noun.

A-t-il de l'argent sur lui?	*Has he any money about him?*
Oui, il *en* a.	*Yes, he has some.*
Il n'*en* a pas.	*He has none.*
Avez-vous des amis? Oui, *j'en* ai.	*Have you friends? Yes, I have.*
Vous *en* parlez, *you speak of it.*	J'en ai, *I have some.*
La fortune a son prix; l'imprudent *en* abuse, L'hypocrite *en* médit, et l'honnête homme *en* use. DELILLE.	*Fortune has its worth; the imprudent abuse it, the hypocrite speaks evil of it, and the worthy man uses it.*
Les limites des sciences sont comme l'horizon; plus on *en* approche, plus elles reculent. MME. NECKER.	*The limits of science are like the horizon; the more we approach (them), the more they recede.*
La vie est un dépôt confié par le ciel; Oser *en* disposer, c'est être criminel. GRESSET.	*Life is a trust confided by heaven; to dare to dispose of it is a crime.*
Il a deux frères, moi j'*en* ai trois.	*He has two brothers, I have three.*

Il a de l'argent, mais il n'*en* a pas beaucoup.	*He has money, but he has not much.*
Combien de bouteilles de vin voulez-vous?	*How many bottles of wine will you have?*
J'*en* veux une douzaine.	*I want a dozen.*

Y, *to him, to her, to it, to them, thereto*, etc. This relative pronoun, of both genders and numbers, is used instead of *à lui, à elle, en lui*, etc., in reference to things, sometimes but rarely in reference to persons, and also adverbially in the sense of *there*.

J'*y* pense, *I think of it.*	J'*y* donne mes soins, *I devote my care to it.*
J'ai connu le malheur, et j'*y* sais compatir. GUICHARD.	*I have known misfortune, and I can sympathise with it.*
N'*y* songeons plus, cher Paulin ; plus j'*y* pense, Plus je sens chanceler ma cruelle constance. RACINE.	*Let us think no more of this, dear Paulin; the longer I think of it, the more I feel my cruel constancy waver.*
Vous avez peu de biens ; joignez-*y* ma fortune. DORAT.	*You have but little property; join my fortune to it.*
En quelque pays que j'aie été, j'*y* ai vécu comme si j'eusse dû *y* passer ma vie. MONTESQUIEU.	*In whatever country I have been, I lived (there) as if I was to spend my life in it.*
Je connais cet homme, je ne m'*y* fie pas.	*I know that man, I do not trust him.*

The pronouns *en* and *y* * may be used to avoid the repetition of *any* personal pronoun :—

Je parle souvent de toi, mais j'*y* pense encore plus.	*I often speak, and still more often think, of you.*
Elle ne pense guère à moi, et elle *en* parle rarement.	*She thinks and speaks but rarely of me.*

Où, in which, through which, during which, etc. This pronoun is used in reference to place and time, and never applied to persons. It is common gender and number, and may be replaced by *lequel, laquelle*, etc., and a preposition :—

La ville *où* (or dans laquelle) il demeure.	*The town in which he lives.*
Les rues *où* (or par lesquelles) il a passé.	*The streets through which he passed.*
Le jour *où* (or pendant lequel) je suis arrivé.	*The day on which I arrived.*

INDEFINITE PRONOUNS.

The indefinite pronouns indicate persons and things, without particularising them. They are :—

autrui,	*others.*	l'un l'autre,	*one another.*
chacun,	*everyone*	l'un et l'autre,	*both.*
on,	*one, people, they.*	rien,	*nothing, anything.*
personne,	*no one, nobody.*		
quelqu'un,	*some, somebody.*	tel,	*such.*
quiconque,	*whoever.*	tout,	*everything, whole.*

REMARKS ON THE INDEFINITE PRONOUNS.

Autrui, others. This pronoun is applied only to persons. It has no change of form for gender or number, and is used generally after a preposition :—

L'honnête homme est discret ; il remarque les défauts d'*autrui*, mais il n'en parle jamais. ST. EVREMOND.	*The gentleman is discreet; he observes the defects of others, but never alludes to them.*
Ne fais point *à autrui* ce que tu ne voudrais pas qu'on te fit.	*Do not unto others that which thou wouldest not like to be done unto thee.*

* The use of these two pronouns is subordinate to the preposition required by the verb; *en* can only be used with verbs which require *de*, and *y* with verbs which require *à*.

Chacun, everyone, each one. When this pronoun is absolute, and means *everyone, everybody*, it is invariable :—

Le sens commun n'est pas chose commune, *Chacun* pourtant, croit en avoir assez. VALAINCOURT.	*Common sense is no common thing, though everyone believes he has enough of it.*
Chacun est prosterné devant les gens heureux. DESTOUCHES.	*Everyone bows before the fortunate.*

When *chacun* is used relatively, it may take the form of the feminine :—

Chacune de nous (des femmes) se pretendait supérieure aux autres en beauté. MONTESQUIEU.	*Everyone of us (women) thought herself superior in beauty to the others.*

On (one, people, they) is only used as subject ; and though it always governs its verb in the third person singular, yet it conveys most generally the idea of plurality. It is commonly used in indefinite sentences :—

On dit, *people say, they say, it is said.*	On parle, *somebody speaks*, etc.
On garde sans remords ce qu'on acquiert sans crime. CORNEILLE.	*We (one, people) keep without remorse that which we (one, people) acquire without crime.*
On relit tout Racine; *on* choisit dans Voltaire. DELILLE.	*We (people, they) read again and again all Racine; we (etc.) select in Voltaire.*
On ne surmonte le vice qu'en le fuyant. FÉNELON.	*We conquer vice only by avoiding it.*

On, coming immediately after the words *et, où, si, que*, and *qui*, may be preceded by the article *l'*, used for euphony; this should not be done, however, when *on* precedes a word beginning with *l* :—

Ce que *l'on* conçoit bien, s'exprime clairement. BOILEAU.	*That which one understands well is clearly expressed.*
C'est d'un roi que *l'on* tient cette maxime auguste, Que jamais *on* n'est grand, qu'autant que *l'on* est juste. BOILEAU.	*It is from a king that we derive this august maxim, that one is only great in proportion as he is just.*

NOTE.—*L'on* may be used *before*, but *never after*, a verb. When *on* follows a verb ending with a vowel, *t* is inserted between them for the sake of euphony :—

Vous croira-*t*-on ?	*Will they believe you?*
L'aime-*t*-on ?	*Is he loved?*

The form which *on* assumed in old French was *om* or *hom*, and these are the links in the chain which separate it from the Latin *homo*, from which it is derived.

Personne, no one, nobody, as an indefinite pronoun, is always masculine and singular, and may be used as subject or as object. Like all negative expressions, it requires *ne* before the verb :—

Il n'est *personne* qui ne cherche à se rendre heureux.—*Chinese thought.*	*There is no one who does not seek to render himself happy.*
Personne ne veut être plaint de ses erreurs. VAUVENARGUES.	*No one wishes to be pitied on account of his mistakes.*
Je n'ai vu et n'ai entendu *personne.*	*I have seen and heard nobody.*

Personne also means *anybody*, in which case it does not admit of *ne* being placed before the verb:—

Personne l'a-t-il vu?	*Has anybody seen it?*

Although the pronoun *personne* is masculine, yet the adjective or past participle referring to it may be used in the feminine when it relates distinctly to a feminine noun or pronoun:—

Personne n'était plus *belle* que Cléopâtre. JULLIEN.	*No one (no woman) was more beautiful than Cleopatra.*

NOTE.—The word *personne*, used as a *noun*, and meaning a particular person, is of the feminine gender.

Quelqu'un, somebody, someone, anyone, anybody, used absolutely, is invariable:—

Envier *quelqu'un* c'est s'avouer son inférieur. MLLE. DE L'ESPINASSE.	*To envy anyone is confessing oneself his inferior.*
Quelqu'un a-t-il jamais douté sérieusement de l'existence de Dieu? GIRAULT-DUVIVIER.	*Has anyone ever had serious doubts on the existence of God?*

Quelqu'un, used relatively, changes for gender and number. It has then the sense of *some of, some one of a few*:—

Connaissez-vous *quelqu'une* de ces dames, *quelques uns* de ces messieurs? GIRAULT-DUVIVIER.	*Do you know any one of those ladies, any of those gentlemen?*
Prenez *quelques unes* de ces poires.	*Take a few of these pears.*

Quiconque, meaning *whoever, whosoever*, though generally masculine, may be used in reference to feminine nouns or pronouns. It has no plural, and is only said of persons:—

Quiconque flatte ses maîtres, les trahit. MASSILLON.	*Whoever flatters his masters betrays them.*
Quiconque est capable de mentir, est indigne d'être compté au nombre des hommes. FÉNELON.	*Whoever is capable of falsehood is unworthy to be counted among the number of men.*
Quiconque est soupçonneux, invite la trahison. VOLTAIRE.	*Whoever is suspicious, invites treachery.*
Mesdemoiselles, *quiconque* de vous sortira sera punie.	*Young ladies, whoever of you goes out shall be punished.*

L'un l'autre, one another, each other. This pronoun has for feminine *l'une l'autre*, and for plural *les uns les autres, les unes les autres*:—

Vous vous flattiez *l'un l'autre.*	*You used to flatter one another.*

NOTE.—The preposition used with this pronoun is placed between *l'un* and *l'autre*, and not as in English:—

Elles se nuisent l'une à l'autre.	*They do harm to each other.*

L'un l'autre is used in the singular in reference to two persons, and in the plural in reference to more than two.

L'un . . . l'autre, les uns . . . les autres, l'une . . . l'autre, les unes . . . les autres. the one . . . the other; the ones . . . the others; some:—

Les uns nous suivaient par curiosité, *les autres* par intérêt.	*Some followed us out of curiosity, others out of interest.*

L'un et l'autre, les uns et les autres, l'une et l'autre, les unes et les autres (both). This expression may be used of persons and of things in the singular in reference to two persons or things, or in the plural, in the case of more than two. The preposition should be placed before *l'un*, and repeated before *l'autre*:—

L'un et l'autre sont honnêtes.	*Both are honest.*
Votre frère blâme *les uns et les autres.*	*Your brother blames the ones and the others*
Il parle mal *des unes et des autres.*	*He speaks ill of the ones and of the others.*
Je le ferai *pour l'un et pour l'autre.*	*I will do it for both.*

NOTE.—*L'un et l'autre*, etc., may be used adjectively:—

La Condamine a parcouru *l'un et l'autre* hémisphère.* BUFFON.	*La Condamine travelled over both hemispheres.*
L'un et l'autre consul suivaient ses étendards. CORNEILLE.	*Both consuls followed his standards.*
À *l'une et l'autre* époque, il périt un très grand nombre de citoyens. BARTHÉLEMY.	*At both epochs a large number of citizens perished.*

Rien, nothing, is masculine singular, requires *ne* before the verb, and may be used as subject and as object. *Rien* means also *anything*, in which case it does not admit of *ne* before the verb:—

Rien n'est plus utile.	*Nothing is more useful.*
Il *n'a rien* entendu.	*He has heard nothing.*
Est-il *rien* de plus beau que la vertu?	*Is there anything more beautiful than virtue?*
Je doute que *rien* lui réussisse.	*I doubt whether he will be successful in anything.*

Rien is derived from the Latin *rem*, and only gets its negative force from the *ne* used in conjunction with it. It is sometimes, however, found in a negative sense without *ne*.

Tel, telle, feminine, *such, many a person, many*, is an indefinite pronoun in the following and in similar sentences:—

Tel donne à pleines mains, qui n'oblige personne. CORNEILLE.	*Many a one may give bountifully without obliging anyone.*
Tel brille au second rang, qui s'éclipse au premier. VOLTAIRE.	*Many a person may shine in the second rank, who is eclipsed in the first.*
Tel est pris qui croyait prendre. LA FONTAINE.	*Many are caught while attempting to catch others.*
Telle sans aucun attrait pour la retraite, se consacre au Seigneur par pure fierté. MASSILLON.	*Many [a nun] for whom retreat has no attractions, consecrates herself to the Lord through mere pride.*
Tels que l'on croit d'inutiles amis, dans le besoin rendent de bons services. BOURSAULT.	*Many friends whom we think useless render us, in our need, valuable services.*

Tel, in connection with *Monsieur, Madame*, etc. (as, *Monsieur un tel, Madame une telle, Mr., Mrs.*

* The noun is in the singular, because the word *hémisphère* is understood after the word *l'un*. This rule is observed by the best French authors.

Such-a-one), is used substantively. *Tel* may be used adjectively in the sense of *such*:—

un *tel* homme,	*such a man.*
de *tels* actes,	*such deeds.*

Tout, everyone, everything. This word, employed absolutely, is invariable:—

À la seule vertu, sois sûr que *tout* prospère. F. DE NEUFCHATEAU.	*Be assured that it is with virtue alone that everything prospers.*
Tout n'est pas Caumartin, Bignon, ni d'Aguesseau. BOILEAU.	*Everyone is not Caumartin, Bignon, or d'Aguesseau.*
Son grand génie embrassait *tout.* BOSSUET.	*His great genius embraced everything.*

NOTE.—In the acceptation of *everyone, tout* is getting obsolete.

TRANSLATION FROM FRENCH.

LA PROSE ET LES VERS.

M. Jourdain.—Il faut que je vous fasse une confidence, je suis amoureux d'une personne de grande qualité, et je souhaiterais que vous m'aidassiez à lui écrire quelque chose dans un petit billet que je veux laisser tomber à ses pieds.

Le Maître de Philosophie.—Fort bien !

M. Jourdain.—Cela sera galant, oui ?

Le Maître de Philosophie.—Sans doute. Sont-ce des vers que vous lui voulez écrire?

M. Jourdain.—Non, non, point de vers.

Le Maître de Philosophie.—Vous ne voulez que de la prose.

M. Jourdain.—Non ; je ne veux ni prose, ni vers.

Le Maître de Philosophie.—Il faut bien que ce soit l'un ou l'autre.

M. Jourdain.—Pourquoi?

Le Maître de Philosophie.—Par la raison, monsieur, qu'il n'y a, pour s'exprimer, que la prose ou les vers.

M. Jourdain.—Il n'y a que la prose ou les vers.

Le Maître de Philosophie.—Non, monsieur. Tout ce qui n'est point prose est vers, et tout ce qui n'est point vers est prose.

M. Jourdain.—Et comme l'on parle, qu'est-ce donc que cela?

Le Maître de Philosophie.—De la prose.

M. Jourdain.—Quoi ! Quand je dis : Nicole, apportez-moi mes pantoufles, et me donnez mon bonnet de nuit, c'est de la prose?

Le Maître de Philosophie.—Oui, monsieur.

M. Jourdain.—Par ma foi ! Il y a plus de quarante ans que je dis de la prose sans que j'en susse rien ; et je vous suis le plus obligé du monde de m'avoir appris cela. Je voudrais donc lui mettre dans un billet : "Belle marquise, vos beaux yeux me font mourir d'amour ;" mais je voudrais que cela fût mis d'une manière galante, que cela fût tourné gentiment.

Le Maître de Philosophie.—Mettez que les feux de ses yeux réduisent votre cœur en cendre ; que vous souffrez nuit et jour pour elle les violences d'un. . . .

M. Jourdain.—Non, non, non ; je ne veux point tout cela. Je ne veux que ce que je vous ai dit : "Belle marquise, vos beaux yeux me font mourir d'amour."

Le Maître de Philosophie.—Il faut bien étendre un peu la chose.

M. Jourdain.—Non, vous dis-je. Je ne veux que ces seules paroles-là dans le billet, mais tournées à la mode, bien arrangées, comme il faut. Je vous prie de me dire un peu, pour voir, les diverses manières dont on les peut mettre.

Le Maître de Philosophie.—On peut les mettre premièrement comme vous avez dit : *Belle marquise, vos beaux yeux me font mourir d'amour.* Ou bien : *D'amour mourir me font, belle marquise, vos beaux yeux.* Ou bien : *Vos yeux beaux d'amour me font, belle marquise, mourir.* Ou bien : *Mourir vos beaux yeux, belle marquise, d'amour me font.* Ou bien : *Me font vos beaux yeux, belle marquise, d'amour mourir.*

M. Jourdain.—Mais, de toutes ces façons-là, laquelle est la meilleure?

Le Maître de Philosophie.—Celle que vous avez dite : Belle marquise, vos beaux yeux me font mourir d'amour.

M. Jourdain.—Cependant je n'ai point étudié, et j'ai fait tout cela du premier coup. Je vous remercie de tout mon cœur et je vous prie de venir demain de bonne heure.

Le Maître de Philosophie.—Je n'y manquerai pas.

ACTE II., SCÈNE II., "LE BOURGEOIS GENTILHOMME."

KEY TO TRANSLATION FROM FRENCH (p. 179).

M. Jourdain (to Nicole, the servant). Be quiet, you impertinent girl ; you always thrust yourself into the conversation. I have wealth enough for my daughter. I only want honours, and I wish to make her a marchioness.

Madame Jourdain.—Marchioness?

M. Jourdain.—Yes, Marchioness.

Madame Jourdain.—Alas ! God preserve me from it.

M. Jourdain.—It is a matter I have resolved upon.

Madame Jourdain.—It is a matter to which I will never consent. Marriages with those grander than yourselves are always subject to inconvenient worries. I do not wish my son-in-law to be able to reproach my daughter with her relations, and that she should have children ashamed to call me their grandmamma. If it should happen that she should come and visit me in her grand lady's carriage, and she should fail inadvertently to bow to someone of the neighbourhood, they would not fail to say a hundred foolish things directly. "Do you see," one would say, "this marchioness who cuts such a grand figure? It is the daughter of M. Jourdain, who was only too happy, as a little girl, to play at being a lady with us. She has not always been so high in the world as she is now, and her two grandfathers sold cloth close to the Porte-Saint-Innocent. They have heaped up money for their children, which they pay for now very dear in the other world ; and one never becomes too rich to be honourable people." I do not want all that tittle-tattle, and I want a man, in one word, who is under an obligation to me for my daughter, and to whom I can say, "Sit down there, my son in-law, and dine with me."

M. Jourdain.—Those are, indeed, the sentiments of a small mind, to wish to remain always low down in the world. Don't answer me again ; my daughter shall be a marchioness in spite of everyone, and if you put me in a passion, I will make her a duchess.

ACT III., SCENE XII., "LE BOURGEOIS GENTILHOMME."

ALGEBRA.—IV.

[*Continued from p.* 161.]

DIVISION.

91. (1) A man divided $48x$ apples among 6 boys. How many did each receive?

Here, if 6 boys receive $48x$ apples, it is manifest that 1 boy will receive $\frac{1}{6}$ of $48x$ apples ; but $\frac{1}{6}$ of $48x = 8x$ apples ; for $48x \div 6 = 8x$. Whence $8x$ apples is the answer.

(2) If 8 hats cost $24a$ shillings, what will 1 hat cost?

Here, reasoning as before, 1 hat will cost $\frac{1}{8}$ of $24a$

shillings, but $24a \div 8 = 3a$; therefore $3a$ shillings is the answer.

The process followed in these examples is called DIVISION. *It consists in finding how many times one quantity contains another*, and is *the reverse* of multiplication. The quantity to be divided is called the *dividend;* the *given* factor, the *divisor;* and that which is *required*, the *quotient*.

92. DIVISION, *therefore, is finding a quotient which, multiplied into the divisor, will produce the dividend.* As the product of the divisor and quotient is equal to the dividend, the quotient may be found by resolving the dividend into two such factors that one of them shall be the divisor. The other will, of course, be the quotient.

Suppose, for instance, that abd is to be divided by a. The factors a and bd will produce the dividend. The first of these, being a divisor, may be set aside as the one factor. The other factor is the quotient.

93. *When the divisor therefore is found as a factor in the dividend, the division is performed by cancelling this factor.*

EXAMPLES.—(1) Divide cx by c. *Ans.* x.

(2) Divide dh by d. *Ans.* h.

(3) Divide drx by dr. *Ans.* x.

(4) Divide hmy by hm. *Ans.* y.

(5) Divide $dhxy$ by dy. *Ans.* hx.

94. PROOF.—*Multiply the divisor and the quotient together, and the product will be equal to the dividend if the work is right.*

Thus $ax \div a$ gives the quotient x. *Proof.* Here $x \times a$ gives the dividend ax.

95. If a letter is *repeated* in the dividend, care must be taken that the factor which is rejected be only equal to the divisor.

EXAMPLES.—(1) Divide aab by a. *Ans.* ab.

(2) Divide bbx by b. *Ans.* bx.

(3) Divide $aadddx$ by ad. *Ans.* $addx$.

(4) Divide $aamyyy$ by amy. *Ans.* amy.

(5) Divide $aaaxxxh$ by $aaxx$. *Ans.* axh.

(6) Divide yyy by yy. *Ans.* y.

In such instances as the preceding, it is obvious that we are not to reject *every* letter in the dividend which is the same with one in the divisor.

96. If the dividend consists of *any factors whatever*, expunging one of them is dividing by that factor.

EXAMPLES.—(1) Divide $a(b + d)$ by a. *Ans.* $b + d$.

(2) Divide $a(b + d)$ by $b + d$. *Ans.* a.

(3) Divide $(b+x)(c+d)$ by $b+x$. *Ans.* $c+d$.

(4) Divide $(b + y) \times (d - h)\, x$ by $d - h$. *Ans.* $(b + y)\, x$.

97. If there are *numeral co-efficients prefixed to the letters, the co-efficients of the dividend must be divided by the co-efficients of the divisor.*

EXAMPLES.—(1) Divide $6ab$ by $2b$. *Ans.* $3a$.

(2) Divide $16dxy$ by $4dx$. *Ans.* $4y$.

(3) Divide $25dhr$ by dh. *Ans.* $25r$.

(4) Divide $12xy$ by 3. *Ans.* $4xy$.

(5) Divide $34drx$ by 34. *Ans.* drx.

(6) Divide $20hm$ by m. *Ans.* $20h$.

98. When a simple factor is multiplied into a *compound* one, the former enters into *every* term of the latter. [Art. 76.] Thus a into $b + d$, is $ab + ad$. Such a product is easily resolved again into its original factors. Thus $ab + ad = a \times (b + d)$.

EXAMPLES.—(1) Resolve $ab + ac + ah$ into its factors.

Here $ab + ac + ah = a \times (b + c + h)$. *Ans.*

(2) Resolve $c^2n + c^2dx + c^2y^2$ into its factors. *Ans.* $c^2 \times (n + dx + y^2)$ or $c^2(n + dx + y^2)$.

(3) Resolve $bd + b^2cd^2 + bc^2d$ into its several factors. *Ans.* $bd(1 + bcd + c^2)$.

(4) What are the factors of $amh + amx + amy$? *Ans.* $am(h + x + y)$.

(5) What are the factors of $4ad + 8ah + 12am + 4ay$? *Ans.* $4a(d + 2h + 3m + y)$.

In these examples, if the whole quantity be divided by one of the factors, according to Art. 96, the quotient will be the other factor.

Divide $(ab + ad)$ by a.

Here $ab + ad \div a = b + d$. *Ans.*

Divide $ab + ad$ by $b + d$.

Here $(ab + ad) \div (b + d) = a$. *Ans.*

Hence, if the divisor is contained in *every* term of a *compound* dividend, *it must be cancelled in each.*

(6) Divide $ab + ac$ by a. *Ans.* $b + c$.

(7) Divide $bdh + bdy$ by b. *Ans.* $dh + dy$.

(8) Divide $aah + ay$ by a. *Ans.* $ah + y$.

(9) Divide $drx + dhx + dxy$ by dx. *Ans.* $r + h + y$.

(10) Divide $6ab + 12ac$ by $3a$. *Ans.* $2b + 4c$.

(11) Divide $10dry + 16d$ by $2d$. *Ans.* $5ry + 8$.

(12) Divide $12hx + 8$ by 4. *Ans.* $3hx + 2$.

(13) Divide $35dm + 14dx$ by $7d$. *Ans.* $5m + 2x$.

99. On the other hand, *if a compound expression, containing any factor in every term, be divided by the other quantities connected by their signs, the quotient will be that factor.* [See Art. 98.]

EXAMPLES.—(1) Divide $ab + ac + ah$ by $b + c + h$. *Ans.* a.

(2) Divide $amh + amx + amy$ by $h + x + y$. *Ans.* am.

(3) Divide $4ab + 8ay$ by $b + 2y$. *Ans.* $4a$.

(4) Divide $ahm + ahy$ by $m + y$. *Ans.* ah.

100. In division, as well as in multiplication, the caution must be observed, not to confound *terms* with *factors*. [See Art. 76.]

EXAMPLES.—(1) Divide $(ab + ac)$ by a.

Here $(ab + ac) \div a = b + c$ by Art. 98.

(2) Divide $(ab \times ac)$ by a.

Here $(ab \times ac) \div a = aabc \div a = abc$ by Art. 93.

(3) What is the quotient of $(ab + ac) \div (b + c)$? *Ans.* a.

(4) What is the quotient of $ab \times ac \div (b \times c)$? *Ans.* aa.

RULE FOR SIGNS IN THE QUOTIENT.

101. In division, the same rule is to be observed respecting the signs as in multiplication; that is, if the divisor and dividend are both positive, or both negative, the quotient must be positive: if one is positive and the other negative, the quotient must be negative. [Art. 82.]

This is manifest from the consideration that the product of the divisor and quotient must be the same as the dividend.

For if $+a \times +b = +ab$, then $+ab \div +b = +a$;

If $-a \times +b = -ab$, then $-ab \div +b = -a$;

If $+a \times -b = -ab$, then $-ab \div -b = +a$;

And if $-a \times -b = +ab$, then $+ab \div -b = -a$.

EXAMPLES.—(1) Divide abx by $-a$. *Ans.* $-bx$.

(2) Divide $8a - 10ay$ by $-2a$. *Ans.* $5y - 4$.

(3) Divide $3ax - 6ay$ by $3a$. *Ans.* $x - 2y$.

(4) Divide $6am \times dh$ by $-2a$. *Ans.* $-3mdh$.

102. *If the letters of the divisor are not to be found in the dividend, the division is expressed by writing the divisor under the dividend in the form of a vulgar fraction.*

NOTE.—This is a method of *denoting* division, rather than an actual performing of the operation. But the purposes of division may frequently be answered by these fractional expressions; for as they are of the same nature with other vulgar fractions, they may be added, subtracted, multiplied, or divided.

EXAMPLES.—(1) Divide xy by a.

Here, $xy \div a = \frac{xy}{a}$.

(2) Divide $(d - x)$ by $-h$.

Here, $(d - x) \div -h = \frac{d - x}{-h} = \frac{x - d}{h}$.

And here it may be observed that if the signs of *all* the terms of a fraction be changed both in the numerator and denominator, its value will not be altered; for $\frac{-bc}{-b} = +c = \frac{+bc}{+b}$, and $\frac{bc}{-b} = -c = \frac{-bc}{b}$.

103. If *some* of the letters in the divisor are in each term of the dividend, the fractional expression may be rendered more simple by rejecting equal factors from the numerator and denominator.

EXAMPLE.—Divide ab by ac. *Ans.* $\frac{b}{c}$.

These reductions are made upon the principle that a given divisor is contained in a given dividend, just as many times as *double* the divisor is contained in *double* the dividend; *triple* the divisor in *triple* the dividend, and so on.

104. If the divisor is in some of the terms of the dividend, but not in all, those which contain the divisor may be divided as in Art. 93, and the others set down in the form of a fraction.

EXAMPLE.—Divide $ab + d$ by a.

Here $(ab + d) \div a = \frac{ab + d}{a} = \frac{ab}{a} + \frac{d}{a} = b + \frac{d}{a}$. *Ans.*

105. The quotient of any quantity divided by *itself* or *its equal* is evidently *unity* or 1. Thus $\frac{a}{a} = 1$, $\frac{x}{x} = 1$, $\frac{abc}{abc} = 1$, etc.

EXERCISE 7.

Perform the following exercises in division:—

1. dhx by dy.
2. $ahm - 3ay$ by ab.
3. $ab + bx$ by by.
4. $2am$ by $2ay$.
5. $dxy + rx - hx$ by x.
6. $2ah + ad + x$ by a.
7. $bm + 3y$ by $-b$.
8. $2ay + dh$ by $2a$.
9. $3ax$ by $3x$.
10. $6x$ by $4a + 2x$.
11. $a + b - 3h$ by $a - 3h + b$.
12. $ax + x$ by x.
13. $3bd - 3d$ by $3d$.
14. $4axy - 4a + 8ad$ by $4a$.
15. $3ah + 3 - 6m$ by 3.
16. $25a$ by $5a$.
17. $4x$ by $20x$.

DIVISION BY COMPOUND DIVISORS.

106. If the dividend is *greater* than the divisor, the quotient must be *greater than a unit*; but if the dividend is *less* than the divisor, the quotient must be *less than a unit*.

EXAMPLE.—Divide $ac + bc + ad + bd$ by $a + b$.

Here, arranging the quantities for division as we do in common arithmetic, we have—

Divisor $a+b$) $ac+bc+ad+bd$ ($c+d$ Quotient.

$ac+bc$, the first subtrahend.

$ad+bd$

$ad+bd$, the second subtrahend.

Here ac, the first term of the dividend, divided by a, the first term of the divisor [Art. 92], gives c for the first term of the quotient. Multiplying the whole divisor by this term, we have the product $ac + bc$, which is to be subtracted from the two first terms of the dividend. The two remaining terms are then brought down, as in arithmetical division, and the first of these divided by the first term of the divisor, as before, gives d for the second term of the quotient. Then multiplying the whole divisor by d, we have the product $ad + bd$, which is to be subtracted from the remaining term of the dividend; as no remainder is left, the division is complete.

This operation suggests the following rule, which is founded on the principle that the product of the divisor into the several parts of the quotient is equal to the dividend. [Art. 92.]

107. *Rule.—Arrange the terms so that the letter which is in the first term of the divisor shall also be in the first term of the dividend. If this letter is repeated as a factor, either in the divisor or dividend, or in both, the terms should be arranged in the following order: put that term first which contains this letter the greatest number of times as a factor; then the term containing it the next greatest number of times, and so on.*

EXAMPLE.—Divide $2aab + bbb + 2abb + aaa$ by $aa + bb + ab$.

If we take aa for the *first* term of the *divisor*, the other terms must be arranged according to the number of times a is repeated as a factor in each. Thus—

Divisor. Dividend.

$$\begin{array}{l} aa+ab+bb\,)\,aaa+2aab+2abb+bbb\,(\,a+b \text{ Quotient.} \\ \qquad\qquad\quad \underline{aaa+\ aab+\ abb} \\ \qquad\qquad\qquad\qquad aab+\ abb+bbb \\ \qquad\qquad\qquad\qquad \underline{aab+\ abb+bbb} \end{array}$$

In division, it is necessary that the *strictest attention* be paid to the *rules* for the *signs* in subtraction, multiplication, and division.

EXERCISE 8.

Perform the following exercises in division:—

1. $xx - 2xy + yy \div x - y$.
2. $aa - bb \div a + b$.
3. $bb + 2bc + cc \div b + c$.
4. $aaa + xxx \div a + x$.
5. $2ax - 2aax - 3aaxy + 6aaax + axy - xy \div 2a - y$.
6. $a + b - c - ax - bx + cx \div a + b - c$.
7. $ac + bc + ad + bd \div c + a + b$.
8. $ad - ah + bd - bh \div y + d - h$.

108. From the preceding principles and examples we derive the following

GENERAL RULES FOR DIVISION.

(1) Division, in all cases, may be expressed by writing the divisor under the dividend in the form of a fraction.

(2) When the divisor and dividend are both simple quantities, and have letters or factors common to each: divide the co-efficient of the divisor by that of the dividend, and cancel the factors in the dividend which are equal to those in the divisor.

(3) When the divisor is a simple, and the dividend a compound quantity: divide each term of the dividend by the divisor as before; setting down those terms which cannot be divided in the form of a fraction.

(4) If the divisor and dividend are both compound quantities, arrange the terms according to Art. 107.

(5) To obtain the first term in the quotient, divide the first term of the dividend by the first term of the divisor. Multiply the whole divisor by the term placed in the quotient; subtract the product from the dividend; and to the remainder bring down as many of the following terms as shall be necessary to continue the operation. Divide again by the first term of the divisor, and proceed as before, till all the terms of the dividend are brought down. If the signs in the divisor and dividend are *alike*, the quotient will be $+$; if *unlike*, the quotient will be $-$.

EXERCISE 9.

1. Divide $12aby + 6abx - 18bbm + 24b$ by $6b$.
2. Divide $16a - 12 + 8y + 4 - 20adx + m$ by 4.
3. Divide $(a - 2h) \times (3m + y) \times x$ by $(a - 2h) \times (3m + y)$.
4. Divide $ahd - 4ad + 3ay - a$ by $hd - 4d + 3y - 1$.
5. Divide $ax - ry + ad - 4my - 6 + a$ by $-a$.
6. Divide $amy + 3my - mxy + am - d$ by $-dmy$.
7. Divide $ard - 6a + 2r - hd + 6$ by $2ard$.
8. Divide $6ax - 8 + 2xy + 4 - 6hy$ by $4axy$.
9. Divide $16abcx - 12xyab + 24abxd - 36ahgb$ by $4ab$.
10. Divide $21aaby + 42adxaa + 14aaa - 35aaaab$ by $7aa$.
11. Divide $12abxyz - 6hdabxy + 24xyabm$ by $3abxy$.
12. Divide $3ax - 36bx + 42 - 72cx + 30ax$ by $2x$.
13. Divide $40ab - 4(x + y) + 72 + 12(a + b) + 48c$ by -4.
14. Divide $abx - cdx + 8gx + x$ by $ab - cd + 8g + 1$.
15. Divide $24xyz - 36cd - 48abcd$ by $12xyz - 18cd - 24abcd$.
16. Divide $-ab - ad + ax(a + b) - 42axy + ab$ by $-a$.
17. Divide $6am - 10ah + 20 - 12cd + 17a$ by $-2am$.
18. Divide $xyz + 6x + 2z - 1 + 2xyz(a + b)$ by $6xyz$.
19. Divide $-6ac - 12bc - 6ab - 10 - 2aabbcc$ by $-6abc$.
20. Divide $18abyx + 16abx - 20bbcm + 24ab$ by $2b$.
21. Divide $16x - 24 + 8a + 43 - 20ax - a$ by -4.
22. Divide $(x - y) \times (3a + x) \times b$ by $(x - y) \times (3a + x)$.
23. Divide $41d \times (4 - a) \times (x + y)$ by $(4 - a) \times 41d$.
24. Divide $-40xy + 7abx - 3ahmx$ by $-40y + 7ab - 3ahm$.
25. Divide $20(ab + 1) - 60(ab + 1) + 50(ab + 1)$ by $5a$.
26. Divide $6ax + 2xy - 3ab - by + 3ac + cy + h$ by $3a + y$.
27. Divide $aab - 3aa + 2ab - 6a - 4b + 12$ by $b - 3$.
28. Divide $bb + 3bc + 2cc$ by $b + c$.
29. Divide $8aaab - bbbb$ by $2ab - bb$.
30. Divide $xxx - 3axx + 3aax - aaa$ by $x - a$.
31. Divide $2yyy - 19yy + 26y - 16$ by $y - 8$.
32. Divide $xxxxxx - 1$ by $x - 1$.
33. Divide $4xxxx - 9xx + 6x - 3$ by $2xx + 3x - 1$.

The preceding rule may be thus summed up:—Divide every part or term of the dividend by the whole divisor, and collect the results as in addition; the sum will be the quotient.

EXERCISE 10.

1. Divide ab^2c^3 by abc, and x^5y^3 by x^2y.
2. Divide x^{m+n} and x^{m-n} each by x^n.
3. Divide $a^3x^4 - a^4x^3 + a^5x^2$ by a^2x^2.
4. Divide $2a^5 - 3a^4y - 6a^3y^2$ by $3a^2$.
5. Divide $8a^5b^3 - 10a^4b^4 + 8a^3b^5$ by $3a^3b^2 - 4a^2b^3$.
6. Divide $x^5 - 13a^2x^3 + 12a^3x^2$ by $x^2 + 3ax - 4a^2$.
7. Divide $x^4 - 9x^2y^2 + 12xy^3 - 4y^4$ by $x^2 - 3xy + 2y^2$.
8. Divide $x^4 - 6x^3 + 5x^2 + 12x + 4$ by $x^2 - 3x - 2$.
9. Divide $x^3 + a^3$ by $x - a$.
10. Divide $a^2 - b^2 + 2bc - c^2$ by $a + b - c$.
11. Divide $81x^5 + 24x^8$ by $3x^2 + 2x$.
12. Divide $x^3 + a^3$ by $x^2 + a^2$.

13. Divide $10y^6 - 23ay^5 + 4a^2y^4$ by $5y^4 - 4ay^3 + a^2y^2$.
14. Divide $7x^4 - 26x^3 + 50x^2 - 74x + 35$ by $x^3 - 3x^2 + 5x - 7$.
15. Divide $2x^4 - 3x^3y + 2x^2y^2 + y^4$ by $x - 4y$.
16. Divide x^3 by $x^2 + 2x + 1$.
17. Divide x^5 by $x^2 - 2x + 1$.
18. Divide $x^4 - 8x + 7$ by $x^2 - 3x + 2$.
19. Divide $5x^4 - 6ax^3 - 2a^3x - a^4$ by $x^2 - ax + a^2$.
20. Divide $x^6 - 3x^4v^2 + 3x^2v^4 - v^6$ by $x^3 - 3x^2v + 3xv^2 - v^3$.
21. Divide $3x^6 - 37x^4 + 35x^3 + 7x^2 + 2$ by $x^3 + 3x^2 - 4x - 2$.
22. Divide $9a^3b + 9a^2bc - 4ab^3 + 4b^3c - 9abc^2 - 9bc^3$ by $3a - 2b + 3c$.
23. Divide $a^3 + 3a^2b + 3ab^2 + 2b^3 + 3b^2c + 3bc^2 + c^3$ by $a + 2b + c$.
24. Divide $4x^5 - x^3 + 4x$ by $2x^2 + 3x + 2$.
25. Divide $x - 9x^9 + 8x^{10}$ by $1 - 2x + x^2$.

GREATEST COMMON MEASURE.

109. A *common measure* of two or more quantities is a quantity which will *divide* or *measure* each of them without a remainder. [Art. 30.] Thus $2d$ is a common measure of $12d$, $6d$, $8d$, etc.

110. *The greatest common measure* of two or more quantities is the greatest quantity which will divide these quantities without a remainder. Thus $6d$ is the greatest common measure of $12d$ and $18d$; and 8 is the greatest common measure of 16, 24, and 32.

111. To find the greatest common measure of two given quantities.

Rule.—Divide the greater of the given quantities by the less, the divisor by the remainder, and every successive divisor by its own remainder until nothing remains; the last divisor will be the greatest common measure.

112. To find the greatest common measure of three or more quantities.

Rule.—Find the greatest common measure of any two of them; then the greatest common measure of that one and another of the quantities, and so on, till all the quantities have been employed in the operation; the last divisor is the greatest common measure.

The greatest common measure of two quantities is not altered by multiplying or dividing either of them by any quantity which is not a divisor of the other, and which contains no factor which is a divisor of the other.

The common measure of ab and ac is a. If either be *multiplied* by d, the common measure of abd and ac, or ab and acd, is still a. On the other hand, if ab and acd are the given quantities, the common measure is a; and if acd be *divided* by d, the common measure of ab and ac is a.

113. Hence, in finding the common measure by division, the divisor may often be rendered more simple by dividing it by some quantity which does not contain a divisor of the dividend. Or the dividend may be *multiplied* by a factor which does not contain a measure of the divisor.

EXAMPLE.—Find the greatest common measure of $6a^2 + 11ax + 3x^2$ and $6a^2 + 7ax - 3x^2$.

Here,
$$\begin{array}{r} 6a^2+7ax-3x^2\,)\,6a^2+11ax+3x^2\,(\,1 \\ 6a^2+\ \ 7ax-3x^2 \\ \hline 4ax+6x^2 \text{ Remainder.} \end{array}$$

Now dividing this remainder by $2x$, we have $2a + 3x$ for the next divisor.

$$\begin{array}{rcl} \text{Divisor.} & \text{Dividend.} & \text{Quotient.} \\ 2a + 3x\,) & 6a^2 + 7ax - 3x^2 & (\,3a - x \\ & 6a^2 + 9ax & \\ \hline & -2ax - 3x^2 & \\ & -2ax - 3x^2 & \\ \hline \end{array}$$

The first remainder was divided by $2x$ because it is a common factor of both terms of that remainder, and it cannot form a factor of the common measure, not being a factor of every term in the proposed quantities. As the division of the preceding divisor by this simplified remainder leaves no remainder, therefore $2a + 3x$ is the common measure required.

EXERCISE 11.

1. Find the greatest common measure of $x^3 - b^2x$ and $x^2 + 2bx + b^2$.
2. Find the greatest common measure of $cx + x^2$ and $a^2c + a^2x$.
3. Find the greatest common measure of $3x^3 - 24x - 9$ and $2x^3 - 16x - 6$.
4. Find the greatest common measure of $a^4 - b^4$ and $a^5 - b^2a^3$.
5. Find the greatest common measure of $x^2 - 1$ and $xy + y$.
6. Find the greatest common measure of $x^3 - a^3$ and $x^4 - a^4$.
7. Find the greatest common measure of $a^2 - ab - 2b^2$ and $a^2 - 3ab + 2b^2$.
8. Find the greatest common measure of $a^4 - x^4$ and $a^3 - a^2x - ax^2 + x^3$.
9. Find the greatest common measure of $a^3 - ab^2$ and $a^2 + 2ab + b^2$.

KEY TO EXERCISES.

EXERCISE 6.

1. $15a^2xy$.
2. x^{2n}.
3. x^{m+n}.
4. x^{10}.
5. x^{2n}.
6. x^7y^5.
7. $ax^4y - 3ax^3y^2 + 3ax^2y^3$.
8. $1 - x + x^2 - x^3 - 4x^4$.
9. $x^4 - 2a^2x^2 + a^4$.
10. $2rx - 4x^2 - 3rz + 6xz$.
11. $4a^2 + 6ab - 12a - 18b^2 + 8$.
12. $24abmxy - 8abx + 8abhx$.
13. $1680adhx - 240dxy$.
14. $84abd - 14hd^2 + 14d + 48abdx - 8d^2hx + 8dx$.
15. $3adhy + 2dhy + dh^2 - 4dh + 3ahxy + 2hxy + h^2x - 4hx + 3ady^2 + dy^2 - 4dy + 3axy^2 + xy^2 - 4xy$.
16. $6abhx - 4bh^2 + bdh + 6abx - 4bh + bd + 6ahx - 4h^2 + dh + 6ax - 4h + d$.
17. $2a^2b^2 + 2a^2c^2 + 2b^2c^2 - a^4 - b^4 - c^4$.
18. $x^4 - y^4 - z^4 + v^4 - 2v^2x^2 + 2y^2z^2$.
19. $16x^4 - y^4$.
20. $a^3 + 3a^2b + 3ab^2 + b^3$.
21. $x^3 + x^2y - xy^2 - y^3$.
22. $216abx + 216aby$.
23. $3axyz + 3bxyz + 3cxyz + 3dxyz$.
24. $xxx - yyy$.
25. $aaaaaa - bbbbbb$.
26. $aaa + xxx$.
27. $yyyy - aaaa$.
28. $45aa - 80bbbb$.
29. $12a^2x + 12a^2y + 12abx + 12aby$.
30. $aaaa + 4aaab + 6aabb + 4abbb + bbbb$.
31. $4x^5 - 3x^6 - 4x^7 + 27x^8 - 18x^9$.
32. $35y^6 - 89y^5 + 85y^3 - 17y^2 - 8y$.
33. $a^6 - 2a^5 + 2a^4 - 4a^3 + 6a^2 + 6a - 9$.
34. $r^7 - 7ar^6 + 21a^2r^5 - 35a^3r^4 + 35a^4r^3 - 21a^5r^2 + 7a^6r - a^7$.
35. $x^5 - ax^4 + a^2x^3 + 3a^3x^2 - 4a^4x + 4a^5$.
36. $x^4 - 23x^2 - 18x + 40$.
37. $1 + x^2 - x^3 + x^4 - x^5 - x^7$.

PNEUMATICS.—I.

THE BAROMETER.

WEIGHT OF DRY AIR—ATMOSPHERIC PRESSURE—STANDARD PRESSURE—STANDARD BAROMETER—FORTIN'S—BAROMETRIC CORRECTIONS FOR TEMPERATURE, CAPILLARITY, FOR SEA-LEVEL AND INTENSITY OF GRAVITY.

WE are all familiar with the fact that there is an ocean of air surrounding the earth and extending upwards some 50 or 100 miles. The lower strata of air near the earth are compressed by the weight of all above them; yet we live and move about without inconvenience at the bottom of this atmosphere, just as some fishes enjoy life at the bottom of deep seas, although there is a great weight of water above them. This air, which we breathe to sustain life, forces its way into our bodies and all porous substances, and being an invisible fluid was for a long time supposed to be without weight.

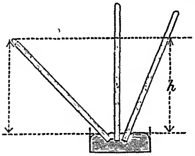


Fig. 1.

In 1650 Otto Guericke conclusively proved by the following experiment that the air has weight. A large glass globe, furnished with a stop-cock, is exhausted of all the air it contained and hung on one scale of a balance. Weights are placed in the scale-pan on the other arm in order to exactly counterbalance the empty globe. When equilibrium is obtained, the stop-cock is opened, allowing air to rush into the globe, which is seen to descend, and additional weight must be added to the other scale-pan to restore equilibrium. This additional weight is clearly that of the air in the globe. In this way dry air at 0° Cent. is found to weigh about 1·293 gramme per litre, that is, 0·0807 pound per cubic foot. This will vary slightly from place to place owing to the variation in the downward pull or attraction of the earth on bodies. If the globe used in the above experiment be filled with the rarefied air found at the highest point reached in a balloon ascent, or if the air in the globe be heated and some of it allowed to escape, the weight of the globeful will be less than in the first instance, simply because the quantity of air contained in it is less.

ATMOSPHERIC PRESSURE.

A force must necessarily be distributed over some area, and the total force exerted divided by the area of surface, in other words, the elastic force exerted by a fluid on unit area is called the *pressure*, or sometimes *pressure-intensity*. Now, *the pressure at any point of a fluid is the same in all directions; and the pressure is the same at all places on the same level in a fluid at rest as a whole.*

The pressure of the air at any place is usually measured by the height of the column of pure mercury it can support, and the instrument used for this purpose is called a *Barometer*. Take a very clean glass tube 35 or 36 inches in length, 0·75 inch diameter of bore, and closed at one end. Fill this tube with perfectly pure mercury, and boil the mercury in the tube to expel all air-bubbles that may be found flattened into a thin film and plastered against the inner surface of the glass when the mercury is introduced. When the tube is perfectly filled with pure mercury, place the thumb over the open end so as to prevent any air entering while the tube is inverted, with its open end down, in a vessel containing mercury (Fig. 1). On removing the thumb, the mercury sinks about five or six inches in the tube when held upright, and the column of mercury stands about 30 inches above the level of the free surface of mercury in the vessel.

The mercury always stands at the same level, and will fill the tube when the latter is inclined down to this level, as shown in Fig. 1. This experiment is due to Torricelli, and the vacant space at the top of the tube above the mercury, which only contains a little mercury vapour, is called the Torricellian vacuum.

Since the mercury in the tube remains at this height h, it is clear that the pressure of the atmosphere at the free external surface of the mercury in the vessel must be equal to that of the column of mercury supported.

Take h to represent the difference of level of the mercury inside and outside the tube of sectional area a, and w the weight of a unit volume of mercury.

Then ha is the volume of mercury in the tube above the free external surface, and the weight of this volume of mercury is wha.

Hence this column of mercury exerts at the free surface level in the tube

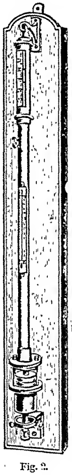


Fig. 2.

$$\text{Pressure} = \frac{wha}{a} = wh,$$

which must be the same as the pressure of the atmosphere on the external surface. Experiment shows that h is about 30 inches, and therefore we conclude that every surface exposed to the atmosphere sustains a total force equal to the weight of a column of mercury about 30 inches in height and having this surface for base. That is to say, *the pressure of the atmosphere is equal to that of a column of pure mercury 30 inches in height at 0° Cent.*

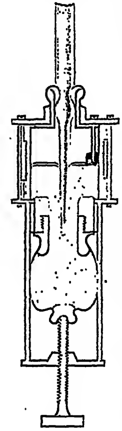


Fig. 3.

Now, if we take water instead of mercury, we know that the weight of mercury is 13·596 times that of water, bulk for bulk, and therefore the height of the water column supported by the atmosphere would be

$$\frac{13·596 \times 30 \text{ inches}}{12} = 34 \text{ feet, nearly.}$$

This is the greatest height to which water can be raised by a common pump. In fact, water will only rise in an empty tube to a height of about 33 feet by the simple action of the atmosphere.

Further, given that one cubic foot of pure water weighs 62·4 lb., we can easily calculate the atmospheric pressure in pounds per square inch. In the first place, a water column 34 feet high and 1 square foot in sectional area, suported by the atmosphere, contains 34 cubic feet of water which weighs

$$34 \times 62·4 = 2121·6 \text{ lb.}$$

Since this force is distributed uniformly over one square foot or 144 square inches, it follows that this column of water exerts a pressure of

$$\frac{2121·6}{144} = 14·73 \text{ lb. per square inch.}$$

Again, we have seen above that one cubic foot of air near the surface of the earth and at 0° Cent. weighs 0·0807 lb.

That is to say, the ratio of the weight of water to that of air per cubic foot is

$$\frac{62·4}{·0807} = 773$$

In other words, air at the sea-level is about 773 times lighter than water. Hence if the air were of the same density everywhere throughout the atmosphere as it is near the surface of the earth, we could find the height H of this imaginary homogeneous atmosphere. The height of this uniform atmosphere would simply be 773 times that of the water column it supports, that is,

$$773 \times 34 = 26,282 \text{ feet,}$$

or about 5 miles. However, we know that the density of the air, instead of being uniform as here supposed, rapidly diminishes as we ascend, and the mercury column indicating the pressure actually falls about an inch for every 900 feet of vertical ascent above sea-level. Besides, air has the property of expanding in volume, according to Boyle's law, as the pressure diminishes when the temperature remains constant. Hence, as the pressure diminishes the volume increases, or the density D diminishes in the same proportion, and H is not affected thereby, because the pressure

$$P = gH \times D,$$

and therefore

$$H = \frac{P}{gD},$$

where g is the intensity of gravity at the place.

It follows that if we neglect variations in temperature of air and assume g or the downward pull of the earth to remain uniform, as the heights increase in arithmetical progression, both the pressure and density decrease in geometrical progression.

Thus the air exerts less pressure, gradually becoming more rarefied, and at a height of, say, 50 miles it would scarcely exert any pressure at all. However, we observe shooting stars and meteors made white-hot by friction against the air about 100 miles above the earth's surface, so that the atmosphere pervades space far beyond this range.

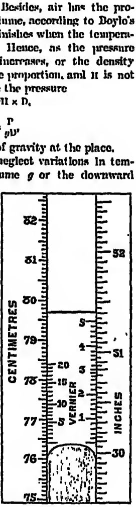


Fig. 4.

STANDARD PRESSURE.

The standard pressure of the atmosphere commonly taken as the average height of the barometer is equal to that of 760 millimetres or 29·922 inches

of pure mercury at 0° Cent. at sea-level in north latitude 45°. The variation in the intensity of gravity makes the standard pressure at the level of the sea in the latitude of London equal to the pressure exerted by a column of pure mercury 29·905 inches in height at 0° Cent.

If H, the height of the barometer, be 76 centimetres at Greenwich, where g, the intensity of gravity, is 981·17, with the density of mercury 13·596 at 0° Cent., the standard pressure P in dynes (units of force) per square centimetres,

$$P = g\,HD,$$

becomes

$$P = 981{\cdot}17 \times 76 \times 13{\cdot}596$$
$$= 1013800 \text{ dynes.}$$

At Paris, where g is 980·94, the same barometric height, 76 centimetres at 0° Cent., is equal to a pressure of

$$980{\cdot}94 \times 76 \times 13{\cdot}596$$
$$= 1013600 \text{ dynes per square centimetre.}$$

To avoid all ambiguity on account of the variation of gravity, some have proposed to take as standard pressure one million dynes, or a *mega-dyne per square centimetre*. This standard is equivalent to 749·64 millimetres, or 29·514 inches, of mercury at 0° Cent., or about 14·5 lb. per square inch, at the sea-level at Greenwich.

STANDARD BAROMETER.

The instrument which serves to measure the amount of the atmospheric pressure is called a *barometer*.

The mercurial barometer in its simplest form consists of a straight clean glass tube closed at one end, and when filled with perfectly pure mercury, all traces of air or moisture being driven out by carefully boiling the mercury in the tube, the tube is inverted, with the open end in a cistern containing pure mercury, also recently boiled. The tube must be about 0·5 inch internal diameter, and long enough to produce a good Torricellian vacuum as above described.

Fortin's barometer is shown in Fig. 2. The glass tube is enclosed in a brass tubular frame for protection, the upper portion of which has two openings, one at the front and the other at the back, so that the upper part of the mercurial column can be seen. At one side of this slit the scale of inches is marked on the brass tube, and on the other the scale of centimetres, as in Fig. 4. A vernier divided for both scales is moved between them by means of a milled head working a rack and pinion.

The cistern or reservoir of Fortin's barometer is of the peculiar construction seen in section, Fig. 3. The lower end of the tube is made narrow where it enters a lining of boxwood at the top of the cistern, and is attached to the brass cover by a piece of chamois leather which prevents the escape of mercury, but is sufficiently porous to allow the air to pass freely through it and thus transmit the pressure of the atmosphere.

The inner lining of the cistern is of boxwood, to which a bag of leather is fastened. The mercury in the cistern may be adjusted to the proper level by means of a thumbscrew passing through the brass-work at the bottom. This level is indicated by a small ivory point, which should be brought just into contact with its image reflected in the mercury, and the ivory point touches the surface. This part of the cistern is made of glass so that the ivory point and mercury can be clearly seen. When the adjusting screw is turned until the top of the cistern and tube are filled with mercury, the instrument may be laid in any position or carried about without injury.

A thermometer attached to the brass tube, as in Fig. 2, gives the temperature at the time of the observation.

The barometer should be fixed in some place where it is not directly heated by a fire or by the sun shining upon it. The ring and bracket at the top allows the barometer to be suspended in the vertical position, in which it is clamped by the three screws through the ring at the bottom. The barometer should be fixed with its base about two or three feet above the ground, so as to have the scales and vernier at a convenient height for reading.

In taking a reading, adjust the level of the mercury in the cistern, observe the temperature, and set the vernier. By means of the milled-head screw the vernier is moved until its lower edge is tangent to the convex surface of the top of the mercurial column. This will be seen by keeping the eye on a level with the lower edges of the vernier at the front and back and adjusting until the light is just cut off the top of the mercury column.

The exact reading is then taken by the vernier, Fig. 4. Each small division on the inch scale is $\frac{1}{20}$th, or ·05 of an inch. Now, twenty-four of these scale divisions are equal to twenty-five divisions on this side of the vernier; therefore our vernier division is $\frac{24}{25}$ths of a small division on the inch scale. That is to say, the difference between each vernier division and a small scale division is $\frac{1}{25}$th of the latter, or

$$\tfrac{1}{25} \text{ of } \tfrac{1}{20} \text{ of 1 inch} = \tfrac{1}{25} \times \tfrac{1}{20}$$
$$= \tfrac{1}{500} = 0{\cdot}002 \text{ inch.}$$

Hence the difference between two vernier divisions and two scale divisions is $2 \times {\cdot}002 = {\cdot}004$ inch, and so on.

Now, in taking a reading, first note the position of the zero point of the vernier on the inch scale. In Fig 4 it is between the first and second divisions above 30, so that we have

Scale reading - - - 30·05 inches.

Next we see the vernier division marked 3 or the 15th division coincides with a scale division. Thus $15 \times \cdot002 = \cdot03$ inch is the distance of the zero of vernier above the 30·05 inches on scale ; and therefore the reading of the barometer is

$$30 \cdot 05 + \cdot 03 = 30 \cdot 08 \text{ inches.}$$

Again, on the metrical scale the large divisions are centimetres, and the small ones are millimetres. On this vernier 20 small divisions are equal to 19 millimetres, so that one vernier division is

$$\tfrac{19}{20}\text{ths} = \cdot 95 \text{ millimetre.}$$

That is each vernier division is ·05 millimetre less than each scale division. Now, in reading the barometer height on this metrical scale, first note that the zero of the vernier is above 763 millimetres, but not quite up to 764 millimetres. Next, we observe that the 18th division of the vernier coincides exactly with a division on the scale. Thus

$$18 \times \cdot 05 = \cdot 90 \text{ millimetres}$$

is the distance that the zero point of the vernier is above 763 millimetres on the scale, and therefore the height of the mercurial column is

$$763 \cdot 9 \text{ millimetres.}$$

BAROMETRIC CORRECTIONS.

The barometric height, observed as above, requires several corrections, so that the readings taken at different times may be compared with one another, as well as with the observed height of the barometer at other places.

1. *Correction for Temperature.*

Like most other substances, mercury expands when heated, so that a mercurial column of given height will exert less pressure hot than cold. In order to compare barometric heights at different temperatures, it is usual to reduce the observed height of the column in every case to the height of a column that would exert the same pressure at 0° Cent.

Let H be the observed height of the mercurial column at $t°$ Cent., and H_0 the corrected height of mercury that would exert the same pressure at 0° Cent. Now, the coefficient of cubical expansion of mercury for 1° Cent. is 0·00018, so that the same quantity of mercury that occupies H divisions of the tube at $t°$ Cent., would occupy only

$$H(1 - 0 \cdot 00018t) \text{ at } 0° \text{ Cent.}$$

Moreover, we must bear in mind that the metal scale on which the divisions are marked also expands when heated. In this case the correction must be made for the increase in length of the scale, the coefficient of linear expansion of brass for 1° Cent. being about ·000019. Hence H divisions of true length at 0° Cent. are actually

$$H(1 + \cdot 000019t) \text{ at } t° \text{ Cent.}$$

This partly compensates for the increased volume of the mercury, and the height of the mercury column varies inversely as the density of the mercury. We have

$$\frac{H_0}{H(1 + \cdot 000019t)} = \frac{1}{1 + \cdot 00018t}$$

that is,

$$\frac{H_0}{H} = \frac{1 + \cdot 000019t}{1 + \cdot 00018t}$$

which reduces to

$$H_0 = H(1 - \cdot 000161t)$$
$$= H - \cdot 000161tH.$$

In other words, we have to deduct the product ·000161tH from the observed height H of the mercury column at $t°$ Cent. to find the true height H_0 of the same quantity of mercury at 0° Cent. which would exert the same pressure.

In English barometers the brass scale is of correct length at 62° Fahr., so that H inches on the scale at $t°$ Fahr. are

$$H[1 + \cdot 00001043(t - 62)];$$

and the correction to be subtracted from the height H of the mercurial column is

$$\frac{H}{1000}(\cdot 09t - 2 \cdot 56).$$

Tables of corrections are given with each instrument for ordinary temperatures and heights.

Care must be taken before reading the barometer to note the temperature indicated by the thermometer attached to the brass casing of the instrument, because the heat from the body of the observer may change the observation, and due precaution must be taken in this respect when strict accuracy is desired.

2. *Correction for Capillarity.*

We observe that in liquids like mercury, which do not wet glass tubes, the upper surface of the column is convex, and the mercurial column does not rise to its proper height in narrow tubes on account of surface tension. This convex depression of the mercury column is most marked when the mercury is rising in narrow tubes. With a tube three-quarters of an inch internal diameter the amount of depression is less than ·001 inch, but this error becomes much greater in narrower tubes, which should not, therefore, be used for delicate work. On this account it is necessary to tap the barometer gently near the top

of the column to enable the mercury to assume its proper shape and position. It is also important to have the mercury clean, so that the level of the mercury in the cistern may be accurately adjusted just to touch the ivory pointer.

Corrections for these errors are best made by comparing the readings with those of a carefully adjusted and preserved standard barometer at the Kew Observatory. At the same time index errors due to graduation of the scale can be detected.

3. *Correction for Sea-level and Intensity of Gravity.*

As we have already seen, the strata of air near the earth's surface are compressed by the ocean of air above them, so that the density of the air decreases as the elevation above the sea-level increases. The difference of level of two places on a mountain may be determined from the difference of height in the barometric column. Further, to reduce the barometer observations at different elevations to the corresponding values at the sea-level for purposes of comparison, the difference of pressure due to the elevation of the places above the sea-level must be added to the observed heights of the barometer.

Variations in the intensity of gravity must also be allowed for when comparing observations made in different latitudes.

GERMAN.—XXII.

[*Continued from p. 193.*]

Nicht wahr, Aufwarten, ETC.

Nicht wahr? "is it not true?" (*lit.*, not true?) answers to our phrases "isn't it?" "wasn't it?" "don't they?" etc., after an assertion, as:—Es ist kaltes Wetter, nicht wahr? it is cold weather, is it not? Sie kennen ihn, nicht wahr? you know him, do you not? Sometimes nicht wahr precedes the assertion, as:—Nicht wahr, Sie sind müde? you are tired, are you not?

Aufwarten (compounded of the particle auf and warten) signifies "to wait upon," "to serve," and governs the dative:—Ich warte Ihnen auf, I wait upon you; Darf ich Ihnen mit einer Tasse Thee aufwarten? may I serve you with a cup of tea? Ich danke Ihnen, sometimes abbreviated to Ich danke, means in addition to our "I thank you," also "No, I thank you," according to the signification intended to be given. Ich bin so frei (*lit.*, I am so free), *or* Ich bitte, is the usual equivalent to our "if you please." Ich mache ihm meine Aufwartung, "I wait upon him" (*lit.*, make my waiting upon him). Warten, when followed by the preposition auf, signifies "to wait for," as:—Ich warte auf ihn, I am waiting for him.

Sollen, with an infinitive, may often be translated into English by the infinitive only, preceded by the preposition *to*, as:—Ich weiß nicht, was ich thun soll, I do not know what to do.

Nicht zum Worte, *or* Zu Worte kommen, signifies, literally, "not to come to the word" or "to words;" that is, "not to be able to speak."

EXAMPLES.

Ihr Herr Vater ist krank, nicht wahr?	Your father is sick, isn't he?
Ich war'tete eine Stunde auf Sie, dann ging ich, und machte dem Fremden meine Auf'wartung.	I waited an hour for you; then I went and waited upon (called upon) the stranger?
Er machte mich darauf auf'merksam, daß die Zeit vorbei' war.	He reminded me (made me observant) that the time was past.
Er wußte nicht, was er thun sollte.	He did not know wha to do.
Die meisten Monar'chen lassen ihrem Willen freien Lauf.	Most monarchs allow their wills free scope.
Der Lärm ließ mich nicht zum Worte kommen.	The noise did not permit me to be understood.

VOCABULARY.

Beschul'digung, *f.* accusation, imputation.
Bier, *n.* beer, ale.
Chocola'de, *f.* chocolate.
E'benfalls, also, too, likewise.
Entschul'digung, *f.* excuse, apology.
Kellner, *m.* waiter, bar-keeper.
Krönung, *f.* coronation.
Ordnen, to regulate, order.
Tasse, *f.* cup, dish.
Umsonst', in vain, vainly.
Verge'bens, in vain, vainly.
Vergnügt', cheerful, merry, delightful.
Widerfah'ren, to happen, befall.

EXERCISE 132.

Translate into English:—

1. Es war eine schöne Stunde, nicht wahr, mein Freund? 2. Ja, das war es, und nicht so bald werde ich sie vergessen. 3. Nicht wahr, der Nachbar war ebenfalls auf dem Feste? 4. Ja, er war dort, und sehr vergnügt. 5. Nicht wahr, es ist schon sehr spät? 6. Nein, es ist noch ziemlich früh. 7. Nicht wahr, es ist nicht Alles wahr, was die Leute sagen? 8. Nein, nicht Alles darf man Ihnen glauben. 9. Ich habe schon eine Stunde auf ihn gewartet, und immer läßt er sich noch nicht sehen. 10. Wir warten auf den aufwartenden Kellner. 11. Wenn Sie es erlauben, werde ich Ihnen heute Nachmittag meine Aufwartung machen. 12. Darf ich Ihnen mit einer Tasse Thee oder Kaffee aufwarten? 13. Ich danke für Thee, aber ich bin so frei, eine Tasse Kaffee anzunehmen. 14. Bei der Krönung der deutschen Kaiser zu Aachen warteten die anwesenden Fürsten auf. 15. Umsonst habe ich ihn darauf

aufmerksam gemacht; er folgt nur seinem Kopfe. 16. Der Lehrer machte die Schüler darauf aufmerksam, wie wohl und gut Gott Alles in der Welt geordnet habe.

EXERCISE 133.

Translate into German:—

1. Your friend whom we saw the day before yesterday is sick, is he not? 2. It was an agreeable evening, was it not, my friend? 3. Yes, it was; and I shall never forget the pleasure we had. 4. Your brother was also there, was he not? 5. It is yet early, is it not? 6. No, it is very late, and we must go. 7. I have waited already an hour for my friend, but still he has not come. 8. I am waiting for our servant. 9. Do not wait for him, I have just sent him out. 10. After I arrived in London, I went directly and waited upon my friend, for whom I had letters of recommendation. 11. May I serve you with a cup of chocolate? 12. No, I thank you.

Schmerzen, Leid thun, ETC.

Schmerzen (to pain) is used like the corresponding English word, as:—Der Gedanke schmerzt mich, the thought pains me; Die Wunde schmerzt ihn, the wound pains him.

Weh (pain), joined with thun (to do, to make), forms the phrase Weh thun, "to pain," "to grieve" (*lit.*, to make or cause pain), as:—Das thut mir weh, that grieves me (it causes me pain); Er hat dem Kinde weh gethan, he has hurt the child; Die Hand thut ihm weh, the hand pains him; Das Kind hat sich weh gethan, the child has hurt itself.

Leid thun (*lit.*, to make, or cause pain) is employed to denote mental sufferings, sorrow, as:—Es thut ihm leid, daß er es gethan hat, he is sorry that he has done it; Es thut mir leid, ihn nicht gesehen zu haben, I am sorry not to have seen him.

Fehlen (to fail, to miss, to lack) is often used impersonally, as:—Es fehlt ihm an Verstand, he was lacking in understanding. So, also, Was fehlt dem Manne? what *ails* the man? Was fehlt Ihnen, what ails you? *or*, what is the matter with you?

EXAMPLES.

Es fiel nichts von Bedeu'tung vor.	Nothing important happened.
Es schmerzt nichts länger und tiefer als das Bewußt'sein, seine Jugend in Thor'heiten vergeu'det zu haben.	Nothing pains longer and more deeply than the consciousness of having spent one's (his) youth in folly.
Sagen Sie mir, was Ihnen fehlt, und was die Ur'sache Ihrer Thränen ist.	Tell me what ails you, and what is the cause of your tears.
Es fehlt mir an Geduld', das Ende meiner Leiden ab'zuwarten.	I lack patience to await the end of my sufferings.
Ein Lobspruch, den ich mir nicht zu'eignen kann, thut mir weher, als ein verdien'ter Verweis'.	A eulogium that I cannot appropriate pains me more than a merited reproof.
Mir thut das schon weh, was andern nur leid thut.	That already pains me which makes others only sorry.

VOCABULARY.

Ab'weichen, to deviate.
Abermals, again, once more.
Begeg'nen, to encounter, meet.
Ding, *n.* a thing.
Erwer'ben, to earn, to get, obtain.
Fehl'gehen, to go wrong, to miss the way.
Gereu'en, to cause to repent.
Gott'losigkeit, *f.* wickedness.
Hinzu'fügen, to add to, to join, adjoin.
Meiden, to avoid, shun, to abstain from.
Nie'derschlagen, to deject, discourage, dishearten.
Pfad, *m.* path.
Sagen, to say, tell.
Scheiden, to part from another.
Schmerzen. (*See* above.)
See'lenruhe, *f.* tranquillity, peace of mind.
Streit, *m.* contest, contention.
Tugend, *f.* virtue.
Un'schuldig, innocent.
Verken'nen, to mistake, to take for another.
Verstimmt', out of humour, out of tune.
Volkslied, *n.* national song.
Vor'fallen, to happen, to come to pass.
Vor'sichtig, careful.
Wahl, *f.* choice.
Zufrie'denheit, *f.* contentedness.
Zu'fügen, to cause, to inflict.

EXERCISE 134.

Translate into English:—

1. Es schmerzt mich, so viele Menschen unglücklich zu sehen. 2. Die Wunde schmerzt ihn mit jedem Tage mehr. 3. Es schmerzt nichts mehr, als von Leuten verkannt zu sein, deren Liebe und Achtung man sich gern erwerben möchte. 4. Es thut mir leid, ihn beleidigt zu haben. 5. Scheiden und Meiden thut weh, sagt ein altes deutsches Volkslied. 6. Der Kopf thut mir weh. 7. Es thut mir in der Seele weh, ihm nicht helfen zu können. 8. Was fehlt Dir, mein Freund, warum so traurig? 9. Es fehlt mir weiter nichts, als daß ich ein wenig verstimmt bin. 10. Sind Sie krank? 11. Ja, ich bin ein wenig unwohl. 12. Was fehlt Ihnen? 13. Ich habe Kopfweh. 14. Sie sind reich und angesehen, und doch sind Sie niedergeschlagen—was fehlt Ihnen? 15. Es fehlt mir viel, „Zufriedenheit und Seelenruhe." 16. All meine Freunde, die versprochen hatten, zu kommen, waren da, nur Einer fehlte. 17. Alle Menschen fehlen. 18. Mein Bruder ist abermals fehl gegangen; statt in mein Haus, ist er in das meines Nachbars gekommen. 19. Seine Worte gereuten ihn, und er versprach, dieselben nie wieder sagen zu wollen. 20. Als dieses vorfiel, war ich nicht zu Hause.

EXERCISE 135.

Translate into German :—

1. It pains a father to hear of the wickedness of his son. 2. Nothing pains more than to be accused innocently. 3. It pains me that so many persons have been found killed by the last storm. 4. I am sorry that you did not find me at home. 5. The wound which the soldier received in the contest pains him. 6. What ails you, my friend? 7. Oh, nothing particularly. 8. You look very ill, what is the matter with you? 9. I am not well; I have hurt myself. 10. He has fallen out of the window. 11. This boy lacks understanding. 12. You have been offended by me; I am sorry, for I esteem you much. 13. You dare not lack courage to encounter the contest with your enemy. 14. I lack patience to await the result of this matter.

Damit, Seitdem, ETC.

Damit (therewith) is often to be rendered by "in order to," "in order that," "so that," etc., as :—Ich muß eilen, damit ich nicht zu spät ankomme, I must hasten, in order not to arrive too late; Ich wollte bitten, daß Sie das thäten, damit ich es nicht thun müßte (Gellert), I would beg you to do that, in order that I might not be obliged to do it.

Seitdem = "since," "since then," "since the *or* that time," as :—Seitdem sie in Deutschland war, spricht sie nichts als Deutsch, since she was in Germany, she speaks nothing but German; Seitdem ist er glücklich, since then (*or* that time) he is happy.

Gefälligst, an adverb in the superlative degree, from the adjective gefällig (pleasing, agreeable), answers to our phrase "please," "if you please," as :—Wollen Sie mir gefälligst sagen, wieviel Uhr es ist? will you please to tell me what time it is? Geben Sie mir gefälligst meinen Hut, please to give me my hat.

EXAMPLES.

Die Deutschen können erst über Literatur' urtheilen, seitdem' sie selbst eine Literatur' haben (Göthe).	The Germans can only judge of literature from the time that (since) they themselves have a literature.
Er ist an'gezogen mit dem Kleide der Gerech'tigkeit.	He is clothed with the garment of justice.
Der Onkel setzte seinen Hut auf und hängte seinen Mantel um.	The uncle put on his hat and cloak (hung his cloak round).
Er eilt heim mit sor'gender Seele, damit' er die Frist nicht verfeh'le (Schiller).	He hastens home with anxious soul in order that he may not miss the appointed time.

VOCABULARY.

Abfahrt, *f.* departure.
Auf'setzen, to put on.
Beispiel, *n.* example.
Eilen, to hasten.
El'terlich, parental.
Ereig'nen, to happen, to occur.
Erkennt'niß, *f.* knowledge.
Fort, away.
Fort'eilen, to hasten away.
Fremde, *f.* foreign country, abroad.
Geschwin'digkeit, *f.* celerity, swiftness.
Heimath, *f.* home, native place.
Hungern, to hunger, starve.
Krönen, to crown.
Nachricht, *f.* intelligence.
Pelz'handschuh, *m.* fur-glove.
Phantasie', *f.* fancy.
Post'wagen, *m.* stage-coach.
Prassen, to gormandise.
Schwelgen, to revel, carouse.
Stürmisch, stormy.
Um'hängen, to hang round, put on.
Umher'irren, to wander about.
Um'werfen, to throw round, put on.
Versäu'men to miss, neglect, lose.
Vortheil, *m.* advantage.
Weichen, to give way, retire.
Weßhalb', why, wherefore.

EXERCISE 136.

Translate into English :—

1. Seitdem ich hier angekommen bin, hat sich schon Manches ereignet. 2. Seitdem er diese That begangen hat, scheint aller Friede von ihm gewichen zu sein. 3. Seitdem er fort ist, habe ich keine recht frohe Stunde mehr. 4. Seit dieser Zeit hat man nichts wieder von ihm gehört. 5. Seit meinem zehnten Jahre habe ich das elterliche Haus verlassen. 6. Seit gestern befinde ich mich nicht ganz wohl. 7. Seit dem Tode seiner Eltern irrt er ohne Heimath in der Fremde umher. 8. Seitdem er zur Erkenntniß seiner selbst gekommen ist, ist er ein ganz anderer Mensch geworden. 9. Er zog sich in aller Geschwindigkeit an. 10. In der Eile vergaß er seine Stiefel anzuziehen, und eilte in den Pantoffeln fort. 11. Seine Kleider waren ganz durchnäßt, deßhalb mußte er sich anders anziehen. 12. Er setzte diesen Morgen seinen Hut nicht auf, sondern seine Mütze. 13. Der Diener hängte seinen Herrn nicht, wie gewöhnlich, den Mantel um, sondern er warf ihn sich selber um. 14. Vergessen Sie nicht, Ihren Mantel umzuhängen, es ist sehr kalt und stürmisch. 15. Hängen Sie mir gefälligst meinen Mantel um, und setzen Sie mir meinen Hut auf, denn ich habe schon meine dicken Pelzhandschuhe angezogen. 16. Er stieg auf den höchsten Baum, damit er den König sehen könne. 17. Er war sehr eilig, damit er die Abfahrt des Postwagens nicht versäumen möchte. 18. Er erzählte mir dieses, damit ich mir ein Beispiel daran nehmen möchte. 19. Der Schüler entschuldigte sich damit, daß er keine Zeit gehabt hätte, seine Aufgabe zu lernen. 20. In großen Staaten müssen Hunderte hungern, damit Einer prasse und schwelge: Zehntausende werden gedrückt und in den Tod gejagt, damit ein gekrönter Thor oder Weiser seine Phantasien ausführe.

EXERCISE 137.

Translate into German :—

1. Will you please to give me a cup of coffee or tea? 2. Since yesterday I have not felt quite well. 3. Since he quitted the home of his parents we have not heard anything of him. 4. Since the twelfth year of my age I have not visited my native land.

5. Since he received the intelligence, he has had no peace. 6. In order that my friend may not come in vain, I shall stop at home. 7. I have not seen my friend since he arrived from Germany. 8. Instead of putting on his boots, he went out in his slippers. 9. Tell your friend, if you please, he may visit us at any time. 10. Why does he not take advantage of his youth, in order to acquire the knowledge he wants? 11. How have you been since I saw you last? 12. Finish your exercise, if you have not yet finished it; then you will not be punished by your master.

Lieb, Böse auf, Kennen lernen.

Lieb (beloved, dear, agreeable) may, when applied to *persons*, be rendered (like gern with haben) "dear," as:—Ich habe ihn sehr lieb, he is very *dear* to me. Applied to *things*, lieb with sein signifies "to be *agreeable*," "to *please*," etc., as:—Dieses kleine Geschenk ist mir lieb, this little present *pleases* (is pleasing) me, *or* is dear to me; Es ist mir lieb, daß Sie damit zufrieden sind, I am *glad* (it is pleasing) that you are satisfied with it.

Böse auf (*lit.*, bad upon) and böse über (bad over or *towards*) signify "ill-disposed;" the former being applied chiefly to *persons*, the latter to *things*, as:—Warum sind Sie böse auf ihn? why are you angry at *him?* Er ist böse über mein Lachen, he is angry at my *laughing*.

Kennen lernen (*lit.*, to learn to know) is a German idiomatic expression, which means "to become acquainted with":—Wollen Sie ihn kennen lernen? do you wish to become acquainted with him? Ich habe ihn schon kennen gelernt, I have already become acquainted with him.

EXAMPLES.

Es ist ihm sehr lieb, daß Sie wegen dieser Sache nicht böse auf ihn sind.	He is very glad that you are not angry with him on account of this affair.
Über was sind Sie so böse?	At what are you so angry?
Ich habe Herrn K. vo'riges Jahr kennen gelernt'.	I have become acquainted with Mr. K. (during) the past year.
Wollen Sie mich in diese Gesell'schaft ein'führen?	Will yon introduce me to this company?
Ich will Sie meinen Bekann'ten vor'stellen.	I will introduce you to my acquaintance.
Ich will Sie mit meinen Freunden bekannt' machen.	I will make you acquainted with my friends.
Mein Vetter stellte den Kaiser vor.	My cousin personated the emperor.
Sein Bruder stellte mir vor, daß es unrecht sei.	His brother represented to me that it was wrong.

VOCABULARY.

An'treffen, to meet with.
Befrie'digend, satisfactory.
Besänf'tigen, to pacify, soften.
Ei'gensinnig, stubborn, wilful.
Ein'führen, to usher in, introduce, import.
Erfolg', *m.* result.
Gelin'gen, to succeed.
Gesetz', *n.* law.
Mit'theilen, to impart, communicate, bestow, give.
Unmög'lichkeit, *f.* impossibility.
Verbie'ten, to forbid.
Vor'stellen, to represent, introduce, personate.

EXERCISE 138.

Translate into English:—

1. Es ist mir lieb, daß ich Sie hier antreffe; ich habe Ihnen Wichtiges mitzutheilen. 2. Es ist mir lieb, Sie so wohl zu sehen. 3. Es wäre mir lieb, Sie bald wieder zu sehen. 4. Er ist böse über das Betragen seines Neffen. 5. Er ist böse über das Ausbleiben seines Sohnes. 6. Sie ist böse über sich selbst. 7. Der Freund war böse auf mich, aber ich habe ihn wieder besänftigt. 8. Die Mutter ist böse auf ihr eigensinniges Kind. 9. Ich bin böse auf ihn, weil er mich beleidigt hat. 10. Kennen Sie Herrn N.? 11. Ja, ich habe ihn letzte Woche in dem Hause Ihrer Frau Tante kennen gelernt. 12. Ich lerne ihn mit jedem Tage mehr kennen. 13. Man lernt Jedermann eher kennen, als sich selbst. 14. Wo sind Sie mit diesem Herrn bekannt geworden? 15. Wir kennen uns von Jugend auf, und lernen uns mit jedem Tage mehr kennen. 16. Kennen Sie Fräulein B.? 17. Nein, aber ich hoffe noch mit ihr bekannt zu werden. 18. Dieser Mann wird durch seine trefflichen Werke bald bekannt werden. 19. Herr N. stellte mich dieser Familie vor. 20. Er wurde der Gesellschaft durch seinen Bruder vorgestellt.

EXERCISE 139.

Translate into German:—

1. It would be very agreeable to me if you could leave me to myself. 2. It was very satisfactory to me to see my brother well. 3. I am very glad to hear that your undertaking has succeeded. 4. He is angry at the conduct of his brother. 5. My brother introduced me to Mr. G. 6. Has your sister already become acquainted with my brother? 7. Yes, she became acquainted with him at the last concert. 8. Do you know why your brother is so angry? 9. He is angry with me because I laughed at him. 10. The actor personated Henry IV. very well. 11. That government has introduced good laws. 12. This fashion has been introduced by the French. 13. The import of wine from France is very great.

Der Schlag, Abgehen, Einfallen, ETC.

Der Schlag (the blow, the stroke), commonly connected with rühren, often denotes "palsy,"

"apoplexy," as:—Er ist von dem Schlag gerührt worden, he has been struck with the palsy; Er hatte einen Anfall vom Schlage, he had an apoplectic fit.

Abgehen = "to go away," "to leave," as:—Der Zug ist schon abgegangen, the train has already left (started). Es geht gut ab = "it sells well," as:—Der Wein geht gut ab, the wine sells well (goes off well).

Er läßt sich nichts abgehen = "he lets nothing (advantageous) go from him;" that is, "he stints himself in nothing."

Je nachdem = "ever after," or "according as," as:—Je nachdem ich Muße habe, werde ich Sie besuchen, as (*or* according as) I have leisure I will visit you, etc.

Einfallen signifies literally "to fall in" *or* "into;" hence, "to fall down," *or* "to ruin," "to decay," etc. With the dative, it signifies "to come into the mind," "to occur," as:—Es ist mir nie eingefallen, so etwas zu thun, it never occurred to me to do such a thing.

So fern, or In so fern = "in so far as," "if," "in case," as:—Ich erlaube es dir, in so fern es von mir abhängt, I will permit it, so far as it depends upon me; In so fern es die Zeit erlaubt, if (*or* in case) the time permit, etc.

Angehen, used intransitively, signifies "to begin," as:—Der Gottesdienst in Deutschland geht gewöhnlich des Morgens um neun Uhr an, the church-service in Germany generally commences in the morning at nine o'clock. Used transitively, it signifies "to concern," "to be of consequence," as:—Das geht ihn an, that is his concern, *or* that concerns him; Das geht mich nichts an, that does not concern me (is of no consequence to me).

EXAMPLES.

Der Schlag rührte ihn auf der linken Seite.	The palsy struck him on the left side.
Er stand da wie vom Schlag gerührt.	He stood there as if struck with the palsy.
Wo ging der Streit an?	Where did the contest begin?
Was gehn mich deine Freuden an? (Göthe).	How do thy pleasures concern me?
Das Dampfschiff geht um vier Uhr ab.	The steamboat leaves at four o'clock.
Diese Waare geht gut ab.	This ware sells well.
Dieser Mann läßt sich nichts abgehen.	This man does not stint himself.
Die Unterre'dung ging ruhig ab.	The conference passed off quietly.
Je nachdem die Unterhal'tung ist, ist auch die Stimmung.	According as the entertainment is, so also is the humour.
In so fern Du Recht hast, werde ich Dir nachgeben.	As far as you are right, I will yield to you.

VOCABULARY.

Abgang, *m.* sale, market (run).
Ab'kühlen, to cool.
Debat'te, *f.* debate.
Ein'fallen, to fall in, occur.
Erkäl'ten, to take cold.
Gelaunt', disposed, humoured.
Kümmern, to concern, trouble.
Leidlich, tolerable, supportable.
Naß, wet.
Rasch, quick, swift.
Schnupfen, *m.* cold (in the head).
Sinn, *m.* mind, sense.
Sitzung, *f.* session, sitting.
Un'verträglich, unsociable, intolerant.
Vorsicht, *f.* precaution.
Zu'nehmen, to increase.
Zusam'menfallen, to tumble, to fall together, to fall to ruin.

EXERCISE 140.

Translate into English:—

1. Mein kleiner Bruder hat den Schnupfen; er hat sich auf dem Eise stark erkältet. 2. Wer erhitzt ist und sich zu rasch abkühlt, kann sich leicht erkälten. 3. Wir sollen uns nicht um Dinge kümmern, welche uns nichts angehen. 4. In so weit mich diese Sache angeht, habe ich die nöthigen Schritte gethan. 5. Dieses geht Euch nichts an. 6. Bei dieser Kunde stand er wie vom Schlag gerührt. 7. Den alten Mann hat der Schlag gerührt. 8. Der Mann ist vom Schlage gerührt worden. 9. Wie vom Schlag gerührt sank sie nieder. 10. Diese Waare geht gut ab. 11. Wann geht das nächste Dampfschiff ab? 12. Ich sehe nicht, daß sich dieser Mann etwas abgehen läßt. 13. Ist die Sitzung ruhig abgegangen? 14. Nein, sie ist nicht ruhig abgegangen—die Debatte war sehr stürmisch. 15. Dieses Buch hatte einen starken Abgang. 16. Der junge Kaufmann erzählte mir, daß der Abgang bedeutend zugenommen habe. 17. Je nachdem es mir in den Sinn kommt, reise ich von hier ab. 18. Je nachdem er gelaunt ist, kann er der leidlichste, aber auch der unverträglichste Mensch sein. 19. Je nachdem er es anfängt, wird der Erfolg sein. 20. In so fern ich Dir nützlich sein kann, will ich es von Herzen gern thun.

EXERCISE 141.

Translate into German:—

1. My sister has a cold; she took cold one wet evening. 2. That case does not concern me, and therefore I shall not trouble myself about it. 3. Has the train already left? 4. No, it has not left yet. 5. Has the train left for Oxford? 6. Two trains have already left this morning for Oxford. 7. Did the debate pass off quietly? 8. No, it was a very stormy one. 9. English goods sell well in every country. 10. This grammar has a great sale. 11. According to your knowledge you will be rewarded. 12. Since he has been struck with the palsy he has not been able to attend to his business.

13. He was struck with the palsy during our visit to your house. 14. As far as it concerns me, I shall take every precaution. 15. In spite of their poverty, these people stint themselves in nothing. 16. To mankind nothing is better than a good education. 17. I do not know whether he will grant my request.

KEY TO EXERCISES.

Ex. 126.—1. The diligent scholar is loved and praised by the teacher. 2. Not only wolves and bears, but also birds, are shot by the huntsman. 3. The son was warned by the mother. 4. The letter was brought by the letter-carrier. 5. The poor man's horse has been bought by the Jew. 6. The songs of the Alps have been beautifully sung by the Swiss. 7. The book has been forgotten by the child. 8. The calf has been killed by the butcher. 9. The soldiers will be praised by their commander-in-chief. 10. The good will be rewarded by God. 11. The friend will have been assisted by the neighbour. 12. The poor girl will have been sacrificed by the heathen priest. 13. Cæsar was murdered with the co-operation of his friend Brutus. 14. The steepest rocks are climbed by the chamois-hunters. 15. The favourable moment is seized by the prudent man. 16. There was more done in half an hour than at other times in an hour. 17. The quarrel was carried on with great animosity on both sides. 18. Already many a valuable hour has been misspent (*lit.* unused). 19. The work is finished at last, and will appear in a few days. 20. At last it has been ascertained who is the thief.

Ex. 127.—1. Der Sohn wurde von der Mutter gewärnt. 2. Rom wurde von Remulus gegründet. 3. Es wurde von den Gallieen verbrannt. 4. Dieses Lied wurde von Herrn C. componirt, und von Herrn N. gesungen. 5. Geschickte Leute werden geliebt und gesucht; aber unwissende Leute werden gewöhnlich verachtet. 6. Man vernachlässigt oft seine Pflichten, indem man an seine Vergnügungen denkt. 7. Die heiligsten Pflichten sind oft vernachlässigt worden, indem wir dem Vergnügen zu sehr ergeben waren. 8. Dem Sieger war der Hut mit Blumen geschmückt worden. 9. Die Tapfersten des Heeres werden belohnt werden, je nachdem ihre Thaten anerkannt werden. 10. Deine Schwester wird von ihrem Lehrer geliebt und gelobt, weil sie fleißig und aufmeeksam ist; aber du wirst von dem deinigen getadele werden, weil du nicht gern arbeitest. 11. Karl ist bestraft worden, weil er seine Aufgabe nicht vollendet hatte. 12. Wir wueden von unserm Lehrer gelobt, weil wir fleißig waren. 13. Unser Freund ist bestraft worden, weil er nachlässig gewesen war. 14. Du hast das Vergnügen gehabt, einige Tage bei deinen Feeunden auf dem Lande zuzubringen; du bist von ihnen gelobt und belohnt worden, weil dein Lehrer dir ein voetheilhaftes Zeugniß gegeben hat. 15. Sein Bruder würde besser empfangen worden sein.

Ex. 128.—1. It is said that a representation will be given by the actor. 2. The neighbour believes that the parents are deceived by the boy. 3. The children said that the stag was shot by the huntsman. 4. They fear that the people may be bitten by the dog. 5. They presume the friend has been deceived by his friend. 6. The father thought that the piece had been played by the children. 7. He told me that the flowers in his garden had been plucked by the girls. 8. The old soldier exclaimed that his commander-in-chief would never be forgotten by him. 9. The mother said that it would be dug by her in the garden this afternoon. 10. I should like to know whether he would have been honoured by you. 11. I thought the game would certainly have been won by him. 12. The oracle predicted that he would conquer. 13. He told me he was loved and esteemed by everybody. 14. He affirms that the riddle has been solved by him. 15. History mentions that Troy was demolished by the Hellenic princes. 16. He told him that he would be willing to do everything on his account. 17. The friend complained that he was visited so little by me. 18. They say Hungary was subdued by bribery, not by force of arms. 19. My neighbour told me that this man's exterior presented nothing remarkable, but his mind was adorned by a great many excellent qualities. 20. The aged Cato concluded every speech with the words: "Besides, I am of opinion that Carthage should be demolished." 21. It is supposed that the fort has been occupied by the enemy, but that the garrison will have been pardoned. 22. The youth said that much would yet be accomplished by him. 23. The afflicted father believes that his son may have been shot by the infuriated enemy. 24. The friend affirmed that the calamity had been brought on by the fault of her neighbour. 25. The poor man complained that he had been forcibly carried away.

Ex. 129.—1. Es wurde gesagt, diese Kinder würden von Jedermann geliebt werden. 2. Der Lehrer glaubt, die Aufgabe könnte von den Schülern gelernt worden sein. 3. Der Gärtner sagte, es würde morgen von ihm in dem Garten gegraben werden. 4. Wir wünschen, daß eure Freunde von euch geliebt und geachtet werden. 5. Wir glaubten nicht, daß wir je von unsern Lehrern würden gelobt worden sein, und daß wir sie in Allem würden zufrieden gestellt haben. 6. Es ist unmöglich, daß Sie die Nachricht vor uns können erhalten haben, ausgenommen, sie wäre Ihnen durch den Telegraphen mitgetheilt worden. 7. Wie ist es möglich, daß dieses Unternehmen von Ihnen hätte vollendet werden können? 8. Wir zweifeln sehr, daß wir je für unsere Mühe belohnt werden, und daß die Versprechungen je erfüllt werden können. 9. Wie war es möglich, daß jenes Volk schlecht regiert wurde, da es einen so weisen und guten Fürsten hatte? 10. Der arme Sclave klagte daß er gewaltsam fortgeschleppt werden sei, und im Übermaße seines Schmerzes rief er aus: „O wäre ich nie geboren!"

Ex. 130.—1. Do you not know what disease your niece died of? 2. As far as I have heard, she died of consumption. 3. Many have died of cholera this year. 4. Do they not know who stole the silver spoons? 5. No; but they suspect one of the men-servants of the house. 6. At first they suspected an old waiting-woman. 7. He suspects me of having intentionally offended him. 8. I really do not know upon whom to cast my suspicion, and upon what to support it. 9. After I shall have dressed and breakfasted, I will visit him. 10. After he had dined he read the paper. 11. After he had bathed he took a walk. 12. He even came after ten o'clock in the evening to visit me. 13. After midnight we shall continue our joueney. 14. There are people who after this life expect no other. 15. I rejoice more for his sake than for mine. 16. I undertook the journey on your account. 17. The father is sad on your account. 18. You need not be ashamed on our account. 19. My brother had no longer any command over himself. 20. Have you seen Mr. N. or his lady? 21. I have not only seen, but also spoken to him. 22. A loyal soldier prefers dying to becoming a traitor.

Ex. 131.—1. Sind wir genöthigt, auf unsern Freund zu warten? 2. Nein, nicht seinetwegen. 3. Dieser Mensch wied seiner Treulosigkeit wegen verabscheut. 4. Grämen Sie sich

unsertwegen nicht! 5. Meinetwegen mögen Sie thun, was Sie wollen. 6. Mein Bruder starb im neunzehnten Jahre seines Alters an der Auszehrung. 7. Wissen Sie, wer Ihre goldene Uhr gestohlen hat? 8. Nein, aber ich habe jenen Mann, welcher gestern in unser Haus kam, im Verdachte. 9. Zuerst hatte ich einen Diener des Hauses im Verdachte. 10. Nachdem ich meine letzte Reise vollendet hatte, widmete ich mich dem Studium der lebenden Sprachen. 11. Nachdem wir zu Mittag gespeist hatten, ritten wir spazieren. 12. Nachdem er gefrühstückt hatte, besuchte er seinen Schwager. 13. Diese Dame braucht achtzehn Ellen Musselin zu einem Kleide. 14. Jener Jüngling wurde Doctor. 15. Jenes Unternehmen machte unsern Nachbar zum reichen Mann. 16. Er sagte mir, er würde seiner selbst wegen mit seinem Vater sprechen.

BOOK-KEEPING.—XIV.

[*Continued from p. 183.*]

THE LEDGER (*continued*), PROFIT AND LOSS ACCOUNT, AND BALANCE SHEET.

Dr. DAVID DERRY, HACKNEY. Cr. (29)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 8	To Boots and Shoes	174	7	3	-	Jun. 30	By Balance	64	9	2	-
„ 10	„ do.	174	1	19	-						
			9	2	-				9	2	-
July 1	To Balance		9	2	-						

Dr. BOUGHTON & BOUGHTON, LONDON. Cr. (30)

			£	s.	d.				£	s.	d.
1898.						1898.					
Feb. 14	To Bill (due Ap. 17)	311	95	15	9	Feb. 11	By Tobacco	92	95	15	9
Mch. 11	„ do. (May 14)	311	558	15	-	Mch. 8	„ do.	93	558	15	-
May 11	„ Discount	236	-	2	6	May 9	„ do.	93	15	3	8
	„ Cash	236	15	1	2						
			669	14	5				669	14	5

Dr. JOHN BRIGHTWELL, YORK. Cr. (31)

			£	s.	d.				£	s.	d.
1898.						1898.					
Feb. 28	To Tobacco	172	25	3	2	Mch. 1	By Bill (May 4)	311	25	3	2
Ap. 29	„ do.	173	7	19	3	Ap. 29	„ Discount	235	-	1	4
							„ Cash	235	7	17	11
			33	2	5				33	2	5

Dr. WALTER LOVE, DERBY. Cr. (32)

			£	s.	d.				£	s.	d.
1898.						1898.					
Feb. 28	To Tobacco	172	16	18	-	Feb. 28	By Bill (May 1)	311	16	18	-
„ „	„ Cash	234	80	16	-	Mch. 1	„ Cash	235	80	16	-
			97	14	-				97	14	-

Dr. — JOHN ASHTON, BEDFORD. — Cr. (33)

			£	s.	d.				£	s.	d.
1898.						1898.					
Feb. 15	To Tobacco	172	34	17	6	Feb. 18	By Bill (21 Ap.)	311	34	17	6
Mch. 27	„ do.	173	33	9	2	Mch. 27	„ do. (30 May)	311	33	9	2
May 24	„ do.	174	31	–	10	May 28	„ do. (27 July)		31	–	10
			99	7	6				99	7	6

Dr. — LEONARD LENHAM, CANTERBURY. — Cr. (34)

			£	s.	d.				£	s.	d.
1898.						1898.					
Ap. 22	To Tobacco	173	44	11	8	Ap. 24	By Discount	235	–	7	5
May 28	„ do.	174	29	–	–		„ Cash	235	44	4	3
June 17	„ do.	174	24	15	–	May 31	„ Discount	236	–	4	10
							„ Cash	236	28	15	2
						Jun 19	„ Discount	236	–	4	1
							„ Cash	236	24	10	11
			98	6	8				98	6	8

Dr. — JAMES BALL, LUTON. — Cr. (35)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 29	To Goods on Commisn.	171	22	10	–	Jan. 31	By Discount	234	1	2	6
Feb. 22	„ do.	172	21	15	–		„ Cash	234	21	7	6
Jun. 24	„ do.	174	23	5	–	Feb. 23	„ Discount	234	1	1	9
							„ Cash	234	20	13	3
						Jun. 25	„ Discount	236	1	3	3
							„ Cash	236	22	1	9
			67	10	–				67	10	–

Dr. — ALFRED HAWKES, WORCESTER. — Cr. (36)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan 31	To Goods on Commisn.	171	24	–	–	Jan. 31	By Bill (May 3)	311	24	–	–
Feb. 27	„ do.	172	34	15	–	Feb. 27	„ do. (May 30)	311	34	15	–
			58	15	–				58	15	–

Dr. — DUMAS & FILS, ANTWERP. — Cr. (37)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jun. 26	To Goods on Commisn.	174	63	–	–	Jun. 30	By Balance	64	66	12	6
„ 27	„ Cash	236	1	10	–						
	„ do.	236	1	10	–						
	„ Commission	63	–	12	6						
			66	12	6				66	12	6
July 1	To Balance		66	12	6						

Dr. STEPHEN WHITE (LOAN ACCOUNT). Cr. (38)

			£	s.	d.				£	s.	d.
1898.						1898.					
Feb. 5	To Cash	234	250	–	–	Mch.12	By Cash	235	251	5	–
Mch.12	" Interest and Disct.	62	1	5	–						
			251	5	–				251	5	–

Dr. PHŒNIX FIRE CO. Cr. (39)

			£	s.	d.				£	s.	d.
1898.						1898.					
Ap. 25	To Cash	235	10	13	4	Ap. 26	By Cash	235	10	13	4

Dr. INTEREST AND DISCOUNT. Cr. (40)

			£	s.	d.				£	s.	d.
1898.						1898.					
Jan. 31	To Sundries	371	38	7	6	Jan. 31	By Prall & Son	371	10	19	7
Feb. 28	" do.	372	1	4	3	Mch.12	" Stephen White	62	1	5	–
" "	" Rd. Larking	372	3	7	11	May 31	" Sundries	63	7	17	8
Mch.31	" Sundries	62	1	–	1	Jun. 30	" Bills Payable	63	–	12	–
Ap. 30	" do.	62	3	10	–	" "	" Sundry Expenses	63	87	10	–
May 31	" do.	63	7	12	4		" Profit & Loss	63	81	4	4
Jun. 29	" Mortgage	63	10	–	–						
" 30	" Sundries	63	1	10	4						
" "	" do. (To Cap. a/cs.)	63	122	16	2						
			189	8	7				189	8	7

As previously pointed out, Discount allowed on the payment for goods before the usual period of credit has expired—Trade Discount as it may be called—is not wholly of the nature of Interest, nor is it of the nature of Discount charged on the discounting, under ordinary circumstances, of a bill of exchange, which is only interest under another name. A separate account for Trade Discount would, therefore, be perfectly justifiable.

Dr. COMMISSION. Cr. (41)

			£	s.	d.				£	s.	d.
1898.						1898.					
June 30	To Profit and Loss	63	19	11	–	Mch.31	By Goods on Commis.	62	10	6	–
						Jun. 27	" Dumas & Fils	63	–	12	6
						" 30	" Goods on Commis.	63	8	12	6
			19	11	–				19	11	–

Dr. BAD DEBTS. Cr. (42)

			£	s.	d.				£	s.	d.
1898.						1898.					
June 1	To Geo. Greenfell	63	22	–	5	Jun. 30	By Profit and Loss	63	22	–	5

Dr. SUNDRY EXPENSES. Cr. (43)

1898.			£	s.	d.	1898.			£	s.	d.
Jan. 31	To Petty Cash - -	371	5	2	–	Feb. 28	By Sundries - -	371	–	2	4
Feb. 28	" Cash - - -	372	6	14	6	Jun. 30	" Profit and Loss	63	172	4	
" "	" Petty Cash - -	372	4	18	–						
Mch. 31	" Cash - - -	62	12	7	6						
" "	" Petty Cash - -	62	5	5	–						
Ap. 30	" do. - -	62	4	15	–						
May 31	" do. - -	63	5	10	2						
Jun. 30	" Cash - - -	63	25	14	4						
" "	" Petty Cash - -	63	4	9	10						
" "	" Sundries - -	63	97	10	–						
			172	6	4				172	6	4

The miscellaneous disbursements grouped in an account of Trade Charges or Sundry Expenses, like the present, must depend largely on the kind of business transacted. In those cases, for instance, where rent is one of the chief items of expenditure, rent, local rates, repairs, and annual reduction in value of any leasehold property, form a separate account. Insurances, again, to take a second instance, are of sufficient amount in some businesses to require an account specially for them.

Dr. SALARIES. Cr. (44)

1898.			£	s.	d.	1898.			£	s.	d.
Mch. 31	To Cash - - -	62	25	–	–	Jun. 30	By Profit and Loss	63	50	–	–
Jun. 30	" do. - - -	63	25	–	–						
			50	–	–				50	–	–

Dr. PROFIT AND LOSS. Cr. (45)

1898.			£	s.	d.	1898.			£	s.	d.
Jun. 30	Interest & Discount :—					Jun. 30	Profits on Goods a/cs. :				
	Ordny. (Incldg. Int. on Cap. and Prem.)		81	4	4		Drapery Goods 172 16 2				
	Working Expenses :—						Tea - 13 4 9				
	Salaries - 50 : 0 : 0						Leather Goods 11 19 0				
	Sundry Exs. 172 : 4 : 0		222	4	–		Tobacco Goods 23 2 9				
	Bad Debts :—						221 2 8				
	Geo. Greenfell -		22	–	5		Commissn. 19 11 0		240	13	8
		63	325	8	9		Profits on Investmts. :				
	Net Profits :—						Premises 200 0 0				
	A. Stone (Cap.) 65 14 11	64	131	9	11		British 2¾% 11 5 0		211	5	–
	C. Wood " 65 15 0						Miscellaneous Profits :				
							Suspense - -		5	–	–
			456	18	8			63	456	18	8

Dr. BALANCE. Cr. (46)

1898.		£	s.	d.	£	s.	d.
Jun. 30	To Sundry Debtors :—						
	Dumas & Fils - -	66	12	6			
	David Derry - -	9	2	–			
	Walter Russell - -	14	5	–			
	John Loader - -	77	16	1			
		167	15	7			
	Bills Receivable - -	149	18	1	317	13	8
	To Goods on hand :—						
	Drapery Goods - -	972	9	4			
	Tea - - - -	587	1	10			
	Leather Goods - -	451	1	9			
	Tobacco Goods - -	445	4	11	2,455	17	10
	To Freeholds :—						
	Warehouse and Offices -	3,490	–	–			
	Less Mortgage thereon	510	–	–	2,980	–	–
	To Cash on hand :—						
	Cash at Bank - -	278	8	6			
	Petty Cash - - -	10	–	–	288	8	6
	(64)				6,042	–	–

1898.		£	s.	d.	£	s.	d.
Jun. 30	By Sundry Creditors :—						
	Stephen White (Commission a/c)	77	12	6			
	Prall & Son - -	110	18	6			
	Samuel Perkins -	185	12	11			
		374	3	11			
	Bills Payable - -	513	10	–	887	13	11
	By Capital :—						
	Arthur Stone -	2,577	2	11			
	Caleb Wood - -	2,577	3	2	5,154	6	1
	(64)				6,042	–	–

It will be observed that the items on the credit side of this account are the Liabilities of the business, and those on the debit side the Assets. The ordinary Balance Sheet is a mere repetition of the Balance account, except in so far as the Liabilities and Assets usually change places, the Liabilities being found on the left hand side, and the Assets on the right.

The Balance account is not usually entered with details, as above, but is restricted to the posting of the bare total (£6,042 0s. 0d.) on both debit and credit sides. In its usual form, the Balance account in itself is of no practical value, and is, in consequence, altogether omitted by some book-keepers.

GEOMETRICAL PERSPECTIVE.—VII.

[*Continued from p. 169.*]

PROBLEMS XXXV–XXXIX.

If these two problems upon the same slab, in the same position, and having the same dimensions, but viewed from different points, are well studied, with regard to that especial reason which suggested their introduction—viz., the principle of finding vanishing points for inclined lines and planes, and the method of treating them according to the characters and proportions of the objects, and the view we have of them—they will help to make our future problems possessing more details easy to be understood.

In proportion as the number of lines and angles increase, which compose the subject to be represented in perspective, so there will follow a great amount of working lines, drawn in various directions from the picture plane. Under these circumstances it will frequently be necessary *to use more than one line* to represent the PP, in order to prevent the confusion which must occur when working all the details from *one* PP only. Therefore we are at liberty to use *any number of lines* as picture planes—an advantage fully appreciated by every draughtsman when engaged in making highly finished drawings of very elaborate subjects. The kind of work to which these lessons are but an introduction, and which must fall to the lot of those who have studied perspective for some practical

purpose, will not be restricted to cubes, blocks of wood, and the simple objects we have selected for our practice, and to assist us in explaining the principles. We know the same rule for drawing a block in perspective is applied again in drawing a church or a palace; but respecting the latter, that which increases the labour, and not unfrequently perplexes the student, is the increased amount and the great variety of details. We intend still to confine ourselves to simple examples, so long as we have any new rule to give or fresh principle to explain; let these be well learnt, then the application of them to more extensive and important subjects will be easy. We now, therefore, introduce the practice of *additional picture planes*, and that our explanations may, we trust, be clearer, we will simplify the process by proposing a problem with reference to *two slabs or blocks only*, of the same size, and each in the same position with regard to the PP. By this time our pupils will be prepared with the fact, that if an object *touches* the picture plane *its real length* is represented *upon the picture*: and as it retires from or beyond the picture, the space it occupies upon the PP diminishes. Turn to Fig. 24, Vol. III., page 343, where the slabs of the pavement touching the PP are drawn to the size given by the scale; also $f c$, the perpendicular edge of the cube in Fig. 33, Vol. III., page 346, is another example. After this remark, it will be seen that the object may be made to touch the PP *in more than one place* if it is placed at a distance from the PP, by means of one or more of its lines being produced to the PP as points of contact. Therefore, if we have the option of placing a line representing the PP anywhere in conjunction with one of these points of contact, besides our usual practice of putting it below the drawing, we have the advantage of distributing the measurements, which might be crowded upon this *one* line, upon other lines similarly placed for the same purpose. Any further remarks will be made as we proceed with the method of drawing the following problem:—

PROBLEM XXXV. (Fig. 57).—*Two slabs or rectangular blocks, each of the same dimensions, 6 feet long, 4 feet broad, and 1 foot thick. One block is above the eye, the other below, resting on the ground; in every other respect the conditions of each are the same. Their long sides are 40° with the PP; their nearest angles 3 feet to the left of the eye, and 2 feet within the PP. Height of the eye, 4 feet, and distance of nearest angle to the eye, 10 feet. The vertical space between the blocks is 6 feet.*

Our motive for employing two blocks of the same dimensions and position, with the one exception named, is that we shall find it easier to explain; and we hope our pupils will more clearly understand the use of the PP when placed above the eye, and by which we intend to show that the proportions of the object can with equal capability be arranged upon a line above the HL, as upon one below it. By this use of two lines to represent the PP, the base of a column can be worked from the PP below, and the capital from the one above. The same may be observed when representing windows, balconies, etc., in the upper storeys of a large building. From PS on the HL draw the semicircle DE^1 E DE^2. (We have stated the distance of sight in a way frequently done in some of the military ex-

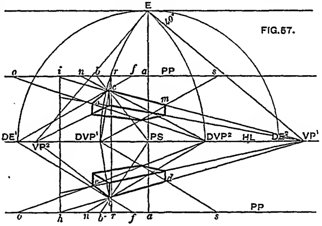


FIG. 57.

amination papers, for the purpose of drawing attention to it. It is said that the distance from the nearest angle to the eye is 10 feet, and that the object is 2 feet within or beyond the PP; therefore the eye will be 8 feet from the PP, which length will be the radius for describing the semicircle through E.) The distance of the nearest angle of the object to the left of the eye will be at b; c the nearest point of the object to the PP, from which lines must be drawn to both vanishing points; the perspective lengths of $c\,d$ and $c\,e$ must be cut off by lines to their respective distance points in the way already explained in lesson V., Vol. IV., page 96. The line $c\,d$, which has been drawn to VP^1, must be produced to the PP in h. The thickness of each block is 1 foot, that being added to the vertical space between them will be 8 feet; therefore the perpendicular line, or *line of contact*, must be 8 feet from h to i. Another PP through i must be drawn parallel to the HL. Now, as the blocks in this case are the same in their dimensions and positions, the upper one could be very quickly

and conveniently drawn from the lower one, by raising perpendicular lines from the angles; but we avoid this for a special reason: that is, we wish our pupils to go through the construction again, upon

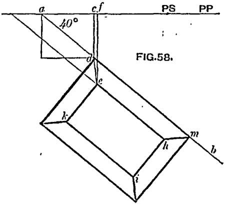


FIG.58.

and from the upper PP, in the same way as they did from the lower; afterwards, a repetition of the process, when, in a future case, the object above varies in size and form from the one below, the difficulties will not be so great. Probably it will be advisable to recapitulate some of the work, to prevent failure. Make *a b* equal to the distance the object is to the left of the eye; draw *b* PS; make *b f* equal to the distance the nearest angle is within the picture; and because the line from *b* vanishes at PS, therefore the line from *f*, to cut off the point within, must be drawn to DE[1], the distance point of E or PS, to determine the nearest part of the object *c*. (Some writers on Perspective call the DE the DPS, meaning *the distance of the point of sight.* It makes no practical difference, because DE[1] or DE[2] represents the space between the eye and the picture plane, that is, between E and PS; PS being on the picture plane, which is supposed to be in a perpendicular position; the line below, marked PP, being its base.—*See* Fig. 21, Vol. III., page 343.) Through *c*, directed from DVP[1], draw a line to *r*; make *r s* equal to the length of the block; draw from *s* back again to DVP[1], which will cut the vanishing line from *c* to VP[1] in *m*; *c m* will then be the perspective representation of the length of the block. Through *c*, directed from DVP[2], draw a line to *n*; make *n o* equal to the width of the block, and rule from *o* back again to DVP[2]; this will cut the line from *c* to VP[2] in *v*; *c v* will be the width of the block. We trust the remainder of the work, including the thickness of the block, will present no difficulties.

We will make further use of this problem, by changing the proportions of the upper block to 4 feet long and 2 feet wide; its plan being in the centre of the plan of the lower one. In this case a plan must be drawn both of the blocks and the PP, to show how the former are situated and connected with the latter, and from which we obtain the proportions and distances of the several parts from one another and from the PP. Therefore Fig. 58 is the first consideration; it is a plan constructed according to the particulars given in the question. Draw the PP. Anywhere, say from *a*, draw the line *a b*, at an angle of 40° with the PP. Upon this last line find the point *d*, the nearest angle within the PP; draw *d c* perpendicularly with the PP; place PS 3 feet to

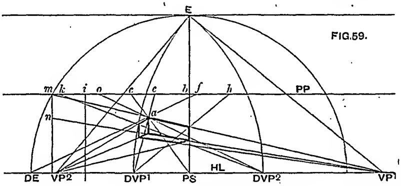


FIG.59.

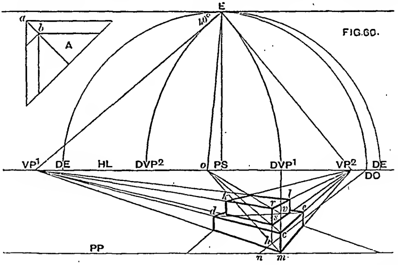


FIG.60.

the right of *c d*. Upon *d m* draw the plan of the lower block; afterwards the plan of the upper one. *c h i k*; all its sides being one foot within the larger plan. In Fig. 59 we have represented only the upper block; the lower one will be simply a repetition of the one in Fig. 57, which our pupils must *not omit repeating* when drawing Fig. 59. We will now commence with the HL, and proceed upwards. The E. DE. PP, and PS will be the same as in Fig. 57. The distance of the nearest angle *a* from the PP must be measured from *b* to *o* on the PP, and equal to PS *o*, taken from Fig. 58. The distance *c f*, of the point *a* within, must be equal to *f c* (Fig. 58). Draw from *a* to VP[1], and also the other way to the PP in *m*; a line from *m* perpendicularly to PP will be *the line of contact*, upon which to measure the thickness, *m n*, of the block. The length and breadth to be cut off on the lines which vanish to VP[1] and VP[2] *must be taken from the plan*, viz., *c h* for the length, and *c k* for the breadth, as shown in *c h* and *o k* (Fig. 59). It will be noticed that the difference of dimensions between the two blocks, and the greater distance of the lower block from the PP, causes a change of position for the line of contact, or rather, another line of contact must be introduced. The perpendicular from *i* is the line of contact for the lower block, while the one from *m* will be the line of contact for the upper; proving that in all cases the first part of the construction to be considered is the position of the nearest point of the object, with regard to the eye and the PP; leaving the rest to whatever may result from the work, according to the varied character of the subject, and the conditions given in the statement.

Before we make any further application of the rule and process of the above problem, we will explain another important step connected with this part of our subject, and afterwards combine the two in an especial case.

Our next consideration will be the way in which we can make use of *a diagonal line* for determining retiring distances and retiring proportions; that is, the angle which the diagonal makes with the PP (we will suppose it to be the diagonal of a square). The diagonal is obtained by bisecting the angle formed by the vanishing lines from E to VP[1] and VP[2]; its VP and distance point DP found, and in all respects treated as are the vanishing lines of the retiring sides.

PROBLEM XXXVI. (Fig. 60).—*Two square slabs of different dimensions, the smaller of which is lying upon the other; the plans of their centres coincide; the nearest angle of the lower one touches the* PP. *The side of the larger slab is 4·5 feet; the smaller, 3 feet. Thickness of each, 1 foot. Angle of sight, distance, and height of the eye, as in the last problem.*

A portion of the subject represented by the plan A must be constructed, *for the purpose of obtaining the length of that part of the diagonal line between a and b*. As the angles of the object are right angles, therefore the angle formed by the vanishing lines from E to the HL will be a right angle. Bisect by the line E *o*; E *o* will then be *the vanishing line of the diagonal* of the slabs, and *o* the VP. Find its distance point by drawing from *o* the arc E DO. After the lower slab, *m o d c*, is drawn according to previous instructions, produce the perpendicular *m c* through *r*; make *m o* and *c r* equal to the thickness of the slabs; in other words, mark their heights on the line of contact from *m*. Draw the diagonals *m o*, *c o*, and *v o*; also the diagonal *d e*. Our object now is to determine the nearest angle of the upper slab. Upon the diagonal of the base, *m o*, we must cut off the distance of *a b*, in the plan A. Make *m n* equal to the line *a b*, and from *n* draw a line to DO, cutting the retiring diagonal *m o* in *h*; *m h* will then be the perspective distance of *a b*. From *h* draw the perpendicular *h s r*; this perpendicular, cutting the diagonal from *c*, gives the nearest angle of the upper slab in *s*; *o v* being the measured thickness of the upper slab, therefore *s r* is the perspective thickness. The diagonal *d o*, cutting the retiring base of the upper slab from *s* each way, gives the perpendicular edges at *l* and *k*. The remaining retiring lines must be directed to their respective vanishing points.

At the foot of the enunciations of several of the problems, we have proposed a scale of some definite number of feet to the inch. Beginners, no doubt, will have found this convenient in assisting them to determine the size of the drawing they may be about to make. We hope by this time they clearly understand that upon the scale depends not only the arrangement and proportions of the parts of the drawing throughout its construction, but also its requisite size upon the paper, to allow sufficient room to ensure a clear representation of all minor details. Therefore it matters little whether the scale is half an inch or one inch to the foot, so long as it is sufficiently large to admit of all that we wish to introduce. Most of the figures attached to our problems are upon a very small scale, for the purpose of economising space; but we advise our pupils to make their drawings from these figures on a larger scale. We have drawn Fig. 61 in the proportion of 3 feet to an inch; a scale of a foot to 1 inch would be better for copying it. We will make use of Problem XXXVII. and its Fig. 61 to assist us in explaining a common difficulty.

It will be seen that in the statement of the problem there are but *two* measurements named; all the rest are referred to the scale of 3 feet to the inch, from which the parts must be measured. The difficulty we allude to is—How are the proportions of the other parts to be obtained upon an increased scale? First, the scale of 3 feet to the inch must be made, and also another and corresponding scale of 1 foot to the inch; the parts of the Fig. 61 may be measured by the scale of 3 feet to the inch, and the *same figures* applied to the 1 inch scale for the drawing in hand. If these simple directions for making a drawing upon increased proportions are exactly followed, it will save much time and space in giving the stated measurements of every part of our subjects; and as we have drawn them to a scale, the additional trouble of making a scale to work from will be but trifling. We propose now to apply the rules and conditions of Problems XXXV. and XXXVI. The first relates to additional picture planes; the second to the use of the diagonal in perspective representation.

PROBLEM XXXVII. (Fig. 61).—*Draw the perspective view of a pedestal, as shown in the plan and elevation* A *and* B. *The height of the eye to be at two-thirds of the height of the pedestal. Nearest angle,* 1 *foot within the picture, and* 2 *feet to the right of the eye; one side is inclined to the picture plane, at an angle of* 35°; *other conditions at pleasure. Scale,* 3 *feet to an inch.*

As there is no necessity to explain all the process of construction from the commencement, we will merely refer to the leading lines and their positions, with whatever additional instruction may be necessary for this particular class of subjects: *a b* two feet to the right of the eye; *b c* one foot within; *c* O the retiring diagonal line, O its VP and DO its distance point. Let the line of contact be drawn from *c*, the point of contact of the diagonal line, because all the heights of the parts of the pedestal must be measured upon it and drawn towards its VP; that is, they are to be taken from the elevation, B, on the line, *c n*, where all the lines of the mouldings are produced for this purpose, and then transferred to the line of contact, *c n*, of the perspective view. It will be noticed that the horizontal projections of the mouldings beyond each other are brought down to perpendicular lines of the plan, A; these must be taken from the plan, commencing at the outer angle, *d*, along the diagonal line, and repeated upon the PP thus:—Draw a line from DO through W to the PP in *d*, make *d m* equal to *d m* of the plan, and rule from *m* back again to DO; from where this line cuts the diagonal, draw a perpendicular; this will give the near angle of the faces of the pedestal. Let this be considered as a rule, *that all the various projections of mouldings, of whatever kind, are brought down to the diagonal of the plan, and treated as we have shown by the construction from m.* The upper PP must be drawn through *n* on the line of contact, and all the points of measurement that have to be made upon it, together with all the lines to be drawn from these points, must be produced and carried out precisely in the same way as when

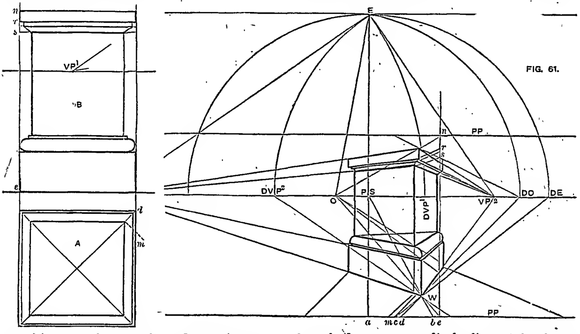


FIG. 61.

they are arranged upon and taken from the PP of the base.

Our next consideration, which is also an important one, will be the use of *half-distance points.* It not unfrequently occurs that the lengths of the lines representing the object are so great that we are unable, from want of sufficient room on the paper, to mark them on the PP for the purpose of cutting them off their respective vanishing lines, guided by their true distance point. When such is the case, we have recourse to the use of *half-distance points.* Our pupils are aware how a distance point is found for any given vanishing point. *If the space on the* HL *between the* VP *and its* DVP *be bisected, the middle point thus found will be the half-distance point.* To explain and illustrate the construction and application of this very useful principle in perspective, we have employed only a single line.

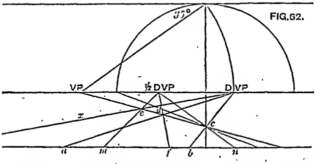
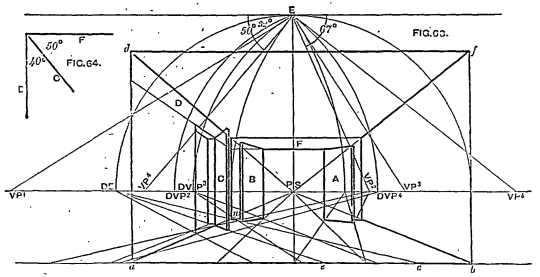


FIG. 62.

PROBLEM XXXVIII. (Fig. 62).—On reference to the figure, it will be seen that $c\,d$ is the perspective view of a line at an angle of 35° with the PP, the real length of which is $a\,b$, from which lines are drawn in the usual way to the DVP. to determine $c\,d$ on the vanishing line. Find the half-distance point by the bisection explained above, mark it ½ DVP. and draw from it a line through c to n; take *half the length* of the given line to be represented, and set it off from n to f, rule from f to ½ DVP. It will be seen that the two lines from n and f pass through the same points c and d to the ½ DVP, which were originally found by the two lines from a and b to the DVP. Suppose it were necessary to represent a line double, or of a greater length than $a\,b$; in this instance we will take double the length to show the advantage of this principle of construction. Make $f\,m$ equal to $f\,n$, and rule from m to the ½ DVP, it will cut the vanishing line in c; $c\,c$ will then be the perspective length of a line equal to twice $a\,b$. Our pupils will see that it is impossible, from want of space, to double the length of $a\,b$ on the PP, and so carry a line from the extreme to the DVP; had there been sufficient room to mark the full length, x would have been the line to the DVP to determine the length of $c\,c$. As we shall have occasion to avail ourselves of the *half-distance point* in some of our future questions, we advise our pupils to exercise themselves in this problem, employing various lengths of lines at various angles.

PROBLEM XXXIX. (Fig. 63).—*The interior of a room in parallel perspective; the retiring portion in view is* 16 *feet long,* 19 *feet wide, and* 12 *feet high. The distance of the eye from the picture plane is* 12 *feet, and its height from the ground is* 4 *feet. At the further end are folding doors* 10 *feet high, and* 4 *feet*



wide; also a single door at the side, the height and width of which are the same. The door A *is at an angle of* 32° *with the connecting wall, the door* B *at an angle of* 67°, *and* C *at an angle of* 40° *with its wall, and* 5 *feet from the further corner of the room.*

In this case the PS will be the VP for the retiring walls on both sides; the width of the room is marked off from *a* to *b* on the PP and ruled to the PS; the height is *a d* and *b f*; the depth to be represented, viz., 16 feet, is set off from *a* to *c*, and a line from *c* to DE will cut off the length of the room in the point *n* on the line from *a* to PS; from this point *n* a perpendicular line is to be drawn to represent the corner of the room, to meet the lines from *d* and *f* to the PS; from this perpendicular draw lines across (that is, parallel with the HL) to meet the corresponding lines of the opposite retiring wall; thus will be determined the further end upon which are fixed the folding doors A and B. How to find their vanishing points and cut off their widths, we trust it will not be necessary to repeat, but merely remark that VP[1] is the VP for the door A, VP[3] for the door B, and VP[4] for C. To ascertain the vanishing point for the retiring thickness of a door, it will be found by drawing a line from E to the HL at a right angle with the line of its VP; for example, VP[2] is the VP for the retiring thickness of the door A.

With regard to drawing the true position of the door at the side, there may be a difficulty not yet explained. Here is a case, which frequently occurs, of a line or plane *at an angle or inclination with something else than the picture plane.* In the case before us, a door is stated to be at *a given angle with its wall*, whilst at the same time the wall is at *a right angle* with the PP. The difficulty is how to find the VP for the door. The proposition states that it is at an angle of 40° with its own wall. The difficulty will not be great if we know the angle to the PP of the intermediate plane to which the given object is inclined; because, if the wall D (*see* Fig. 64) upon which the door swings is at a right angle with the wall F, and C, the door, is at an angle of 40° with D, therefore C will be at an angle of 50° with F; but F is parallel with the PP, therefore the door C will be at an angle of 50° with the PP. Consequently, we shall find the VP of the door (Fig. 63) by drawing a line from E at 50° with the PP, producing VP[4]. To find its distance from the corner of the room at *n*, mark the point *e* 5 feet from *c*, rule from *e* to DE, and where this line cuts the line from *a* to PS will be found the position of that side of the doorway upon which the door swings: the heights of the doors are set off from *o*.

ENGLISH.—XXII.

[*Continued from p.* 164.]

PREFIXES (*continued*).

Ob-, of Latin origin (as a preposition, *on account of*), has the general meaning of *towards*, and hence *at, near*, and varies with the word with which it is connected, the meaning of which it sometimes merely strengthens. In *ob*ject' (Latin, jacio, *I throw*), to throw before or against, it conveys the idea of obstruction, an idea which it expresses more fully in *ob*struction (Latin, struo, *I build*); which, according to its constituents, signifies a building or blocking up. In *ob*literate (Latin, litura, *an erasure*), to blot out, it has an augmentive force. Passing into the first letter of its principal, *ob-* becomes *oc-*, as in *oc*casion (Latin, cado, *I fall*), a suitable fall, a fall *before* you so as to suit your purpose, something seasonable and convenient, by which you may profit. *Ob-* passes also into *of-*, as in *of*fer (Latin, fero, *I bear*). This *of-* must not be confounded with *of-* or *off-* signifying *from*, and found in *off*-scouring and *off*spring:

> "Our prayer hath
> No power to pass; and thou hast made us fall,
> As refuse and *off-scouring* to them all."—*Donne.*

"Whence it follows that these were nations not descending from us, but born with us; not our *offspring*, but our brethren."—*South.*

Octo-, also *octa-*, of Greek origin (ὀκτώ, octo, *eight*), appears in *octa*gon, eight-angled; *octo*syllable, of eight-syllables; *octo*teuch, the first eight books of the Old Testament. In October and octogenarian, *octo-* is of Latin origin.

Olig-, of Greek origin (ὀλίγος, *a few*), is the first part of *olig*archy (Greek, αρχη, pronounced ar'-ke, *government*), government by a few; *olig*arch, one of a small number of rulers.

Omni-, of Latin origin (omnis, *all*), is seen in *omni*scient (Latin, scio, *I know*), all-knowing: *omni*potent (Latin, potens, *powerful*), all-powerful; *omni*present, existing everywhere; *omni*vorous, all-devouring.

Ortho-, of Greek origin (from ὀρθός, *straight, right*), as in *ortho*doxy, right opinion; *ortho*gonal, right-angled; *ortho*pædic, right-footed, etc.

This prefix forms part also of *ortho*graphy (from Greek, ὀρθογραφία), right writing—that is, in the spelling of words; as *ortho*epy (from Greek, ὀρθοέπεια) is right pronunciation.

Over-, of English origin, as in *over*arch, *over*balance, *over*bear, *over*charge, *over*board, *over*-boil, *over*-bounteous, frequently denoting *too much*, as *over*-careful—that is, careful to excess. *Over*come has two significations, to conquer, and to come over or upon.

"He found the means to subdue both the one and the other, compelling as well the *overcomers* as the *overcome* to be his tributaries."—*Brande*, "*Quintus Curtius.*"

> "Can such things be
> And *overcome* us like a summer's cloud,
> Without our special wonder?"—*Shakespeare.*

To *over*take is to come up with in walking or running.

> "And had he not in his extremest need
> Been helped through the swiftness of his steed,
> He had him *overtaken* in his flight."—*Spenser.*

In the passive the verb *overtake* seems to denote the being suddenly *surprised* into an action: *surprise* is from the French *surprendre* (consisting of sur, *above* or *over*, and prendre, *to take*), whence *surprise* is the same as *overtake* in both derivation and meaning.

"Brethren, if a man be *overtaken* in a fault."—Gal. vi. 1.

It is not difficult to see how to overtake may mean to get over, overcome, surprise, but how it means to come up with is less easy to conceive. The notion of *over*, or of superiority may, however, lie in the act by which you succeed in coming up to the person you wish to overtake; thus, by walking more quickly than he, you overtake your friend, you *take* a step *over* his, and get beyond him.

Out-, of English origin, *beyond a certain limit*, is a very common prefix, as in *out*bid, *out*do, *out*face, *out*law, *out*live, *out*strip, etc. *Outrage* has nothing to do with *out-*. *Outrage* comes from the mediæval Latin word ultragium, through the French oultraige, *outrage*. Ultragium, from ultra, *beyond*, denoted a surplusage paid to the lord by his subject on failure of paying his dues in proper time, whence *outrage* came to signify something in excess, and to have an offensive meaning.

Pan-, of Greek origin (πᾶς, πᾶσα, πᾶν, *all*), is found in *pan*acea (from Greek, πανάκεια), all-heal, a universal remedy; in *pan*creas (from Greek, πάγκρεας, *flesh*), all flesh—that is, the sweetbread; and in *pan*dects (Greek, πανδέκται, from πᾶν and δέχομαι, *I receive*), a common title of the Greek miscellanies. This term is known in history in its application to a digest of the civil law published by the Emperor Justinian. Again, *pan-* occurs in *pan*theism—that is, the system which regards God and the universe as the same. We see the crude form of πᾶς in *pan*to, which forms the first part of pantomime (from Greek, παντόμιμος), all-mimicry, because the performance formerly consisted solely of imitation.

"The *pantomimes* who maintained their reputation from the age of Augustus to the sixth century, expressed, without the use of words, the various fables of the gods and heroes of antiquity; and the perfection of their art, which sometimes disarmed the gravity of the philosopher, always excited the applause and wonder of the people."—*Gibbon*, "*Roman Empire.*"

Para-, of Greek origin (παρά, *by the side of*), has in English various acceptations. In *para*ble (from Greek, παραβολή), it denotes something put by the side of another thing, a comparison, a similitude. In Scripture, the parables of the Old Testament are short, pithy, and weighty sayings; the parables of the New Testament are short tales, setting forth religious truth under similitudes; the former are apothegms; the latter allegories. *Para-* also appears in *para*clete (from Greek, παράκλητος), the Advocate or Comforter (John xiv. 16).

Paradise is a Persian word, denoting a park, and has no connection with the Greek *para-*. In Hebrew it is *pardes*, a garden.

Pent- or *penta-*, of Greek origin (πεντέ, *five*), as in *penta*gon, a figure having five sides; *penta*teuch (*five books*), the name given to what are called "the five books of Moses"—namely, Genesis, Exodus, Leviticus, Numbers, and Deuteronomy.

Per-, of Latin origin, *through*, *by*; as, *per*adventure, *by chance*. It is found in *per*ambulate (Latin ambulo, *I walk*), to walk through, over. In some words, such as *pel*lucid, *per-* assumes the form *pel-*.

Peri-, of Greek origin (περί, *around*), as, *peri*phery, (from Greek, περιφέρεια), a circumference; also in *peri*phrasis (from Greek, περίφρασις), a circumlocution, or roundabout mode of utterance.

Phil- and *philo-*, of Greek origin (φίλος, *fond of*), as in *philo*loger, a lover of the science of language; *philo*sopher (from Greek, φιλόσοφος), a lover of wisdom; *phil*anthropy (from Greek, φιλανθρωπία), the love of mankind.

Poly-, of Greek origin (πολύς, *many*, *much*), appears in *poly*anthus (from Greek, πολύανθος), so called from its many flowers; and in *poly*gamy (from Greek, πολυγαμία), the marrying of many wives.

Poly- is also the first syllable of *poly*glot, one who knows *many* languages; also a book written in *many* languages, as the "Polyglot Bible."

Post-, of Latin origin, *after*, *afterwards*, appears in *post*date, to date after the time of writing, at some later time; in *post*pone (Latin, pono, *I place*), *to put off*; and in *post*script (Latin, scriptum, *a writing*), something added to a letter.

Postumous, generally but erroneously spelt posthumous, from the Latin postumus, the same as postremus (from post, *after*), signifies late, very late, the latest, the last. This word is applied to a child born after the father's death, or a book published after the author's death.

Sometimes the word is spelt post*h*ume, for postume. We have here an instance of the effect on spelling of an erroneous etymology. Postume was thought to be composed of post, *after*, and humus, *the ground*, and hence the word was written posthume. It is, however, the superlative of the Latin

posterus, and is used in the Latin language with the same application as in English.

Pre-, of Latin origin, *before*, as in *pre*caution (from Latin, cavere, *to beware*), forethought.

> "*Precaution* trudgeth all about
> To see the candles fairly out."
> *Churchill*, "*The Ghost.*"

Pre- is found in *pre*cede (Latin, cedo, *I go*); in *pre*cipitous (Latin, caput, *the head*), headlong; in *pre*cocious (Latin, coquere, *to cook*), cooked before, forward, too soon ready.

"I had heard of divers forward and precose youths, and some I have known, but I never did either heare or reade of anything like to this sweete child."—*Evelyn*, "*Memoirs.*"

Preter-, of Latin origin (præter, *against*), is found in *preter*-natural, contrary to nature.

Pro-, of Latin origin, *fore, forward*, as in *pro*duce (Latin, duco, *I lead*), to bring forward. *Pro-* appears in *pro*ceed (Latin, cedo, *I go*), in *pro*create (Latin, creo, *I beget*), in *pro*ffer (Latin, fero, *I bear*). The preposition πρό also exists in Greek, and is found in some English words derived from Greek, *e.g.*, *pro*lepsis, an anticipation.

Pro- becomes in French *pour-*, which again becomes *pur-* in English, as in *pur*port (Latin, porto, *I carry*), signification.

Proto-, of Greek origin (πρῶτος, *first*), occurs in *proto*-martyr (martyr, *a witness*), the first witness or martyr: applied to Stephen, in Church history.

> "With Hampden, firm assertor of her laws,
> And *protomartyr* in the glorious cause."—*Boyse.*

Also in *proto*type. We have already had *anti*type and *arche*type: here we have *proto*type, which means the first or original form or model.

Pseudo-, of Greek origin (ψεῦδος, *a falsehood*), signifies what is not genuine, false: as, *pseudo*-prophet, a false prophet; *pseud*onym, a false name (from Greek ψευδώνυμος, called by a false name).

"Out of a more tenacious cling to worldly respects, he stands up for all the rest to justify a long usurpation and convicted *pseudepiscopacy* of prelates."—*Milton.*

Quadr-, *quadra-*, of Latin origin (quatuor, *four*), is found in *quad*rangle, four-angled; *quad*ruped (Latin, pes, *a foot*), fourfooted; *quad*ruple (Latin, plica, *a fold*), fourfold; also *quater-*, as in *quater*nion (quaternio, *the number four*), etc.

> "Air and ye elements, the eldest birth
> Of Nature's womb, that in *quaternion* run,
> Perpetual circle, multiform; and mix
> And nourish all things."—*Milton*, "*Paradise Lost.*"

"I have chosen to write my poem (*Annus Mirabilis*) in *quatrains* or stanzas of *four* in alternate rhyme, because I have ever judged them more noble and of greater dignity both for the sound and number than any other verse in use amongst us."—*Dryden.*

Quinque- (*quint-*), Latin, *five*, occurs in *quinqu*ennial (Latin, annus, *a year*), happening every five years; in *quint*essence (Latin, essentia, *essence*); and in *quint*uple, fivefold.

"Aristoteles of Stagira hath put down for principles these three, to wit, a certain forme called *entelechia*, matter, [and] privation: for elements *four*; and for a fifth, *quintessence*, the heavenly body which is immutable."—*Holland*, "*Plutarch.*"

Re- (*red-*), of Latin origin, primarily signifies *back*, backward (and has nothing to do with *ere*, nor does it mean *before*, as Richardson states), as *re*turn, to turn back; hence opposition, as *re*sist, to stand against; also *re*petition, as *re*vive, to live again; *re*form, to make again.

Re-, denoting back:—

"To desire there were no God, were plainly to unwish their own being, which must needs be annihilated in the subtraction of that essence which substantially supported them, and *re*strains them from *regression* into nothing."—*Browne.* "*Vulgar Errors.*"

Re-, denoting opposition:—

> "To this sweet voyce a dainty musique fitted
> Its well-tuned strings, and to her notes consorted;
> And while with skilful voice the song she dittied,
> The babbling echo had her words *retorted*."—*Spenser.*

Re-, denoting repetition, as in *re*hearse, *re*capitulate, *re*move, etc.:—

> "The land of silence and of death
> Attends my next *remove*."—*Watts.*

Re- sometimes merely strengthens the word, as in *re*ceive, *re*ception (Latin, capio, *I take*), and *re*commend (Latin, mando, from manus, *a hand*; and do, *I give*). In the following words *re-* has the form *red-*, *red*eem, *red*uction, *red*olent, *red*undant. It appears as *ren-* in *ren*der.

Rect-, of Latin origin (rectus, *straight*), appears in *rect*ify (Latin, facio, *I make*), to make straight; in *rect*angular (Latin, angulus, *a corner*), right-angled; *recti*linear (Latin, linea, *a line*), straight-lined; and *recti*tude, uprightness.

Retro-, Latin, *backward*, as in *retro*gression (Latin, gradior, *I walk*), going backward. It is found also, in *retro*active (Latin, ago, *I do, act*), acting in a backward direction.

"A bill of pains and penalties was introduced, a *retroactive* statute, to punish the offences which did not exist at the time they were committed."—*Gibbon*, "*Memoirs.*"

Se-, of Latin origin, denotes separation, *apart from*, *without*: as, *se*clude (Latin, claudo, *I shut*), to shut out; *se*cede (Latin, *I go, yield*), to withdraw from; *se*duce (Latin, duco, *I lead*), to lead from duty.

> "From the fine gold I *separate* the allay,
> And show how hasty writers sometimes stray."
> *Dryden*, "*Art of Poetry.*"

Sept-, of Latin origin (septem, *seven*), appears in *sept*ennial (annus), occurring every seven years; and

in *septen*trion, the seven stars, the Great Bear, Charles's Wain, the north.

> "Thou art as opposite to every good
> As the antipodes are unto us,
> Or as the South to the *Septentrion*."
> *Shakespeare*, "*Henry VI.*" (3rd pt.)

Sex- (Latin, *six*) is found in *sex*angular, six-angled; *sex*ennial, every six years; *sex*tuple, six-fold; *sex*agenary, threescore, etc.

"These are the *sexagenary* fair ones, who, whether they were handsome or not in the last century, ought at least in this to reduce themselves to a decency of dress suitable to their years." —*Chesterfield*, "*Common Sense*."

Soli-, of Latin origin (solus, *alone*), is seen in *soli*loquy (Latin, loquor, *I speak*), a speaking alone, being the only speaker: called also a *mono*logue; and in *soli*fidian (Latin, fides, *faith*), one who supposes faith, and not works, *alone* necessary to justification.

"Such is the persuasion of the *Solifidians*, that all religion consists in believing aright."—*Hammond*.

Sub-, in Latin *under*, as in *sub*terranean (Latin, terra, *the earth*), under the earth; *sub*mersion (Latin, mergo, *I dip*), dipping; *sub*scribe (Latin, scribo, *I write*), to write the name under a document. *Sub-* may denote an inferior degree of the quality of the adjective to which it is prefixed, as *sub*-acid: *sub*-deacon, an *under*-deacon. *Sub-* becomes *suc-* in succession, *suc*cumb, etc.; *suf-*, in sufficient, *suf*fragan, etc.; *sug-*, in *sug*gest, *sug*gestion, etc.; *sum-*, in *sum*mons, etc.; *sup-*, in *sup*port, etc.; *sur-*, in *sur*prise, etc.; and *sus-*, in *sus*tain, etc.

> "To nurse
> The growing seeds of wisdom that *suggest*,
> By every pleasing image they present,
> Reflections such as meliorate the heart,
> Compose the passions, and exalt the mind."
> *Cowper*, "*Task*."

Subter-, meaning *under*, is *sub-* in another form, and appears in *subter*fuge (Latin, fuga, *flight*), an evasion.

Super-, of Latin origin, the opposite of *sub-*, signifies *over*, *above*, as in *super*natural, *above* nature; *super*mundane, *above* the world; *super*vision (Latin, video, *I see*), overlooking.

Sur-, a French abbreviation of *super-*, appears in *sur*charge, an *over*charge, an additional charge; in *sur*coat, an *over*coat; in *sur*tout, literally an *over*all (French, tout, *all*); in *sur*feit (French, faire, *to do*), an *over*doing—that is, eating too much.

"There are various degrees of strength in judgment, from the lowest *surmise* to notion, opinion, persuasion, and the highest assurance which we call certainty."
Search, "*Light of Nature*."

Syn-, of Greek origin (σύν, *with*), occurs in the forms *syl-*, *sym-*, *syn-*; as in *syl*logism, *sym*phonious, *syn*chronous, etc.

"Men have endeavoured to transforme logick, or the art of reasoning, into a sort of mechanism, and to teach boys to *syllogise*, or frame arguments and refute them, without any real inward knowledge of the question."—*Watt's* "*Logick*."

> "Up he rode,
> Followed with acclamation and the sound
> *Symphonious* of ten thousand harps that tuned
> Angelic harmonies." *Milton*, "*Paradise Lost*."

"Sensations are impressed either at the same instant of time, or in contiguous successive instants. Hence it follows that the corresponding associations are either *synchronous* or successive."—*Belsham*, "*Philosophy of the Mind*."

Tetra-, of Greek origin (τέτρα, four), appears in *tetra*gonal, four-angled; *tetra*meter, a line consisting of four measures or feet, and in *tetra*rch, properly a governor of a fourth part, a subordinate prince.

"And Eroude *tetrark* herde alle thingis that weren don of him."—*Wiclif*, "*Testament*" (Luke ix., 7).

Trans-, in Latin, across, as in *trans*pose, to put across from one place to another; *trans*port, to carry over the fire.

> "With *transport* views the airy rule his own,
> And swells on an imaginary throne."—*Pope*.

Tri-, of Latin origin (tres, tres, tria, *three*), appears in *tri*angle, *tri*dent (Latin, dens, *a tooth*), Neptune's sceptre; in *tri*lateral (Latin, latus, *a side*), three-sided, and *tri*literal, having three letters, etc.

"When a county is divided into three of these intermediate jurisdictions, they are called *trithings*. These trithings still subsist in the county of York, where, by an easy corruption, they are denominated *ridings*—the north, the east, and the west riding."—*Blackstone*, "*Commentaries*."

Vice-, of Latin origin, signifying *in the place of*, as in *vice*gerent (Latin, gero, *I bear*), one governing as a substitute, *vice*roy, or "vice-king," see Hakluyt: also *vice*-chancellor, *vice*-president.

"In the yeare 1228, one Reginald was *viceroy*, or petie king of Man."—*Holinshed*.

Vicar (Latin, *vicarius*), comes from *vice*, and so denotes one *who is in the place of another*, hence a "vicarious sacrifice."

> "Nature, *the vicare* of the Almighty Lord,
> That hote, colde, hevie, light, moist, and drie
> Hath knit, by even number of acord,
> In easie voice began to speak and say."—*Chaucer*.

"Then it was devised that, by their common seal (which is the tongue of their corporation), they might appoint a deputy or *vicar* to do it for them."—*Spelman*, "*On Tythes*."

Viscount is made up of the same prefix—that is, *vice*—and the Latin word *comes*, *a companion*, in low Latin *count* or *earl*; so that *viscount* (pronounced vi'count) is the deputy, the lieutenant of the count or earl.

"The *viscount*, called either *procomes* or *vicecomes* in time past, governed in the countie under the earle, but now without any such service or office; it is also become a name of dignity next after the earle, and in degree before the baron." —*Holinshed*, "*Description of England*."

Ultra-, of Latin origin (ultra, *beyond*), is used in *ultra*marine (Latin, mare, *the sea*), properly, beyond the sea; applied to colour, *fine blue*.

"*Ultramarine* or azure is a very light and a very sweet colour."—*Dryden*, "*On Painting.*"

The blue colouring matter of the lapis-lazuli, or azure-stone, is called ultramarine.

Vivi- (Latin, vivus, *alive*) appears in *vivi*fy, to make alive; and in *vivi*parous (Latin, pario, *I bring forth*), bearing (its young) alive.

"The usual distinction of animals, with respect to their manner of generation, has been into the oviparous (Latin, ovum, *an egg*), and viviparous kinds; or, in other words, into those that bring an egg, which is afterwards hatched into life; and those that bring forth their young alive and perfect."—*Goldsmith*, "*Animated Nature.*"

Un-, of English origin, *not*, reverses the meaning of the word to which it is prefixed, as *un*natural, not natural, the opposite of natural.

"Thus was I, sleeping, by a brother's hand,
Of life, of crown, and queen, at once despatched;
Cut off even in the blossoms of my sin
Unhousel'd, disappointed, *unanel'd*."
Shakespeare, "*Hamlet.*"

*Un*anel'd is *unanoiled*, not having received the oil of extreme unction; disappointed means *not prepared*. To *housel* is to minister the communion to one who is on his death-bed. *Housel* comes from the Saxon husel, *the host*, or sacrifice of "the sacrament of the Lord's Supper."

Un- (*uni-*), from the Latin unus, *one*, is exemplified in *un*animous (Latin, animus, *mind*), of one mind; in *uni*parous, bearing one at a birth; in *uni*son (Latin, sonus, *sound*), one single sound; in *uni*vocal (Latin, vox, *a voice*), having one voice or meaning; in *uni*corn (Latin, cornu, *a horn*), an animal with *one* horn; and *uni*form (Latin, forma, *form*), having *one* form.

Under-, of English origin, is found in such words as *under*sell, *under*prop, *under*value, *under*went. In the word *under*stand, the derivative or secondary meaning is very remote from its primitive; namely, to *stand under*. *Under*taker and *under*writer have, in process of time, come to have very special significations. *Under*taker, originally one who took on himself a certain duty, is at present applied to persons who are entrusted with the management of funerals; and *under*writers, properly signifying those who wrote (their names) *under* a legal document (in Latin, *subscriptor*), is a word limited to persons who render themselves liable in a policy of marine insurance.

Up-, of English origin, is found in *up*hill, *up*hold, *up*lift, *up*spring, *up*start, &c.

HYDRAULICS.—II.

[*Continued from p. 146.*]

FLUID PRESSURE.

STANDARD PRESSURE—TRANSMISSION OF PRESSURE BY FLUIDS—MECHANICAL ADVANTAGE OF FORCING PUMP—WORK DONE ON AND BY WATER—HYDRAULIC PRESS—MECHANICAL ADVANTAGE, VELOCITY RATIO, AND EFFICIENCY OF HYDRAULIC PRESS—LEATHER PACKING—LIFTING JACKS AND BOLT FORCER.

WHEN a fluid, such as water, is at rest, every little particle is perfectly free to slide past its neighbour and cannot offer any resistance to doing so. An ideal perfect fluid is, then supposed to have no viscosity, and any force it can exert must be entirely normal, or at right angles to any surface in contact with it. Thus, water at rest cannot press obliquely, either on neighbouring particles of water, or against any surface. Now, when a fluid presses on a surface, the force exerted will be uniformly distributed over some area, however small, and the force exerted divided by this area—that is, the average *force on unit area* is called the average *intensity of pressure*, or simply the *pressure*. A small surface of area a, in contact with a fluid, is acted on by the fluid with a total normal force F, then

$$\frac{F}{a} = p, \text{ that is, } \frac{\text{Fluid Force}}{\text{Area}} = \text{pressure.}$$

Pressure is usually expressed as so many pounds on each square inch; or in dynes (units of force) per square centimetre of surface. When great pressures are considered, the unit of intensity commonly taken is *an atmosphere*, which is about 14·73 pounds per square inch. The standard atmospheric pressure is that exerted by 76 centimetres of pure mercury at 0° Cent., and this expressed in dynes per square centimetre of surface at the sea-level at Greenwich, where $g = 981{\cdot}17$, becomes

$$76 \times 13{\cdot}596 \times 981{\cdot}17$$
$$= 1{,}013{,}800 \text{ dynes.}$$

Or in round numbers a pressure of one atmosphere is about 1,000,000 dynes—that is, one mega-dyne per square centimetre.

Again, the pressure must be the same in all directions at any point of a fluid like water when not in motion; since, from the nature of a fluid there can be no oblique pressure or tangential force between its particles at any point, otherwise one particle would offer frictional resistance to another sliding past it, which we know is not the case.

TRANSMISSION OF FLUID PRESSURE.

It is found that pressure transmitted across any interface separating two portions of a fluid is

everywhere at right angles to that surface. Further, leaving the weight of the water out of account when it is insignificant compared with the pressure, any little cube of the liquid sustains equal pressure on all its faces, and this pressure is equally distributed over any surface confining the water.

Take a closed vessel full of water, and having two apertures fitted with cylindric tubes (Fig. 5), of areas A and *a*, in which water-tight pistons move freely without friction. In the first place, suppose the tubes A and *a* to be each one square inch in area, then if the piston in *a* be pressed down with a force of 40 lb., the water will press against the piston A with the same force, and balance will be maintained by pressing A in with an increased force of 40 lb. In fact the water presses against the inner surface of the vessel everywhere with a force of 40 lb. per square inch. When the area of A is two square inches, a force of 2 × 40 or 80 lb. must be exerted to make the piston in A withstand the pressure of 40 lb. on *a*, which is one square inch in area, and the pressure everywhere in the vessel will be 40 lb. per square inch.

In general the total pressures on the two pistons are simply proportional to the areas A and *a* of the cylindric tubes in which they move, and we find that *a change of pressure applied to any part of a fluid is transmitted equally in all directions throughout the whole substance of the fluid to the inner surface of the containing vessel.* This law of the perfect transmission of pressure by fluids is known as Pascal's principle.

Suppose the diameter of the cylindric tube A is three times that of *a*, then the sectional area of A is nine times that of *a*, and the total force on A will require to be nine times the pressure exerted by the piston *a* on the fluid, in order to maintain the piston in its position. Thus the total pressure sustained by each piston is simply proportional to its sectional area.

The mechanical application of this important principle may be illustrated experimentally by the arrangement shown in diagram Fig. 6. Plungers are fitted into two water-tight tubes of sectional areas A and *a* square inches, in communication by a passage filled with water. Suppose that the plunger in the small tube *a* is one square inch in sectional area, and the large plunger in A is 10 square inches in section. When the small plunger *a* is forced down *one inch* into its

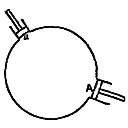


Fig. 5.

tube it will drive out and take the place of one cubic inch of water, since one inch length of the tube, one square inch in section, contains one cubic inch. This cubic inch of water driven out of the smaller tube can only find room for itself in the larger tube A by pushing up the plunger, supposing the water practically incompressible and the sides of the tubes are of sufficient strength to withstand the pressure without yielding, whilst there is no leakage or escape of water. The large tube is ten square inches in sectional area, and therefore, the one cubic inch of water driven into it will occupy $\frac{1}{10}$th of an inch in length of the tube A, so that the larger plunger will be lifted 0·1 inch to leave a cubic inch of space below it for the water forced out of the small tube. If the plunger *a* be pressed down another inch, the other plunger A must rise another tenth of an inch, and the distances moved through by *a* and A are as 10 to 1, or inversely as their sectional areas.

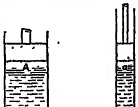


Fig. 6.

Thus we see that *a* moves down ten times as fast as A rises, and the total pressure on *a* will balance ten times its amount at A. Besides, it does not matter what shape the ends of the plungers are, whether flat or curved, because when *a* moves one inch in the tube, the space swept out is simply one inch length of the tube as before, and the relative pressure and velocity of the plungers remain unchanged.

The relative speeds at which the plungers move up and down are inversely as their sectional areas, whilst the total pressure on each is simply proportional to its area.

If the small plunger of one square inch in section is pressed down with a force of 60 lb., this pressure is transmitted through the water, and acts normal to the inner surface of the containing tubes, trying to burst them, as well as on the larger plunger A. The area of A is 10 square inches, and the total force exerted on its lower surface by the water will be 60 × 10, or 600 lb., tending to lift the plunger. Hence it is found that a force of 600 lb. acting on the larger plunger A is necessary to balance a force of 60 lb. exerted on the plunger in the small tube *a*. If there were no frictional resistance to overcome, the mechanical advantage from the one plunger to the other would in this case be 10, that is, simply the number of times the sectional area of the one plunger is greater than the area of the other.

Now what is the amount of work done on and by the water in this example?

Let us neglect, for the moment, the energy always wasted in friction of the plungers rubbing against the inner surfaces of the cylinders and packing required to make them water-tight. We will also take for granted that the water is not diminished in volume by the pressure to which it is subjected.

The work done by the force of 60 lb. in pressing the small piston down through a distance of one inch, or $\frac{1}{12}$ th of a foot, is

$$60 \times \frac{1}{12} = 5 \text{ foot-pounds};$$

whilst the amount of work done by the water in pushing up the larger piston through one-tenth of an inch, or $\frac{1}{120}$ th of a foot, with a total force of 600 lb. is

$$600 \times \frac{1}{120} = 5 \text{ foot-pounds}$$

The work done *on* the water by the small plunger is exactly equal to the work done *by* the water in lifting the larger plunger. This agrees with the law of work, that the total store of energy given to any machine is equal to the energy given out by the machine, provided there is no storage of energy in the machine, nor any waste by friction.

The small piston gives to the water 5 ft.-lb. of mechanical energy, and the water gives this out again by the larger plunger lifting 600 lb. one-tenth of an inch high. In practical cases, some of the work will always be spent in overcoming friction, and we can never expect to get all the work out of a machine that is put into it.

We shall now express these results in general terms. If A and a represent the areas of the plungers in square feet, let d_1 and d be the distances in feet, or lengths of cylinder moved through by the large and small plunger respectively; whilst the pressure on the plungers, and throughout the water is p pounds per square foot. When the small plunger is forced down with a total pressure of $p\,a$ pounds it squeezes $a\,d$ cubic feet of water out of the small cylinder. This water tries to escape, and presses against the sides of the cylinders, trying to burst them, and resists the motion of the plunger a, until the large plunger gives way, and is pressed upwards through the distance d_1 feet, leaving behind it an empty space equal to the volume of the water driven out of the other cylinder, and since the volume of water remains unchanged we have

$$A\,d_1 = a\,d,$$

which may be thrown into the form

$$\frac{d}{d_1} = \frac{A}{a};$$

in other words, the distances moved through by the plungers are inversely as their sectional areas.

Further, the total force required to press down the small plunger is $p\,a$ pounds, and since the water pressure is p pounds on every square foot of surface in contact with it, the large plunger will be lifted or pushed upwards with a total pressure of pA pounds, so that this force is $\frac{p\,A}{p\,a} = \frac{A}{a}$ times as great as that on the small one.

Hence,

$\frac{A}{a}$ is the mechanical advantage.

As regards work done, we see that the total force or $p\,a$ lb. of the small plunger overcoming the resistance of the water through a distance of d feet gives to the water

$p\,a\,d$ foot-pounds of mechanical energy

The water in lifting the large plunger against a resistance of p A pounds through a height of d_1 feet does

p A d_1 foot-pounds of work.

Here the weights of the plungers are neglected, and if there is no waste due to friction, nor storage of energy in the water, we find

$$p\,a\,d \text{ ft.-lb.} = p\,A\,d_1 \text{ ft.-lb.}$$

This is obviously true, since $a\,d = A\,d_1 =$ volume of

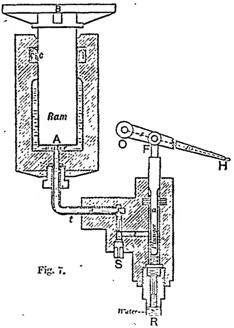


Fig. 7.

water which is driven out of one cylinder into the other, and p is the water pressure.

HYDRAULIC PRESS.

The important principle of equal transmission of pressure by a fluid, such as water, is applied to

many useful purposes in the hydraulic press, shown in section, Fig. 7, which works in much the same way as the simple arrangement in Fig. 6, and is, indeed, merely a practical illustration of the latter, with a lever to apply additional pressure. The small plunger *a* to the right, Fig. 7, is worked by means of a lever turning about the axis O. The mechanical advantage of this lever is the ratio of the length O H to the length O F. When H O is ten times the length of O F, and a man exerts a force of 50 lb. on the end of this lever at H, the plunger *a* will be pressed down with a force of 50 × 10, or 500 lb. The plunger cylinder is filled with water from a cistern or tank R, through the lift-valve *r*, which can only open inwards. During the upstroke of the plunger, leaving an empty space behind it in the cylinder, the pressure is thereby reduced, and the valve *r* is opened by suction in the cylinder as well as by the atmospheric pressure on the surface of the water outside. In this way the water is allowed in to fill the space behind the plunger *a*; and then during its downstroke the valve *v* is pressed down on its seating, and so prevents the escape of the water in that direction. Some of the water will be forced into the tube *t* to the left of the plunger, but is here stopped by the valve *r'*, which is held down on its seating by the water above it in the tube *t* leading to the large plunger A, usually called the ram, since it forces up the table or platten B, with the materials to be pressed, against a framework called the box, not shown here. This box usually consists of a massive top firmly screwed to the framework of the ram cylinder by four wrought-iron columns. For baling cotton or wool, packing hay, and general warehouse purposes, the sides of the box are sometimes closed, forming a framework or box of oak; whilst sets of pressing boxes are provided in the oil-press to squeeze or express oil from seeds for linseed, cotton, rape, olive, and castor oil.

All these things to be pressed or lifted are placed upon the platten B, which weighs down the ram A against the water surrounding its lower end in the cylinder. After a few strokes of the plunger *a*, the bent tube *t*, and all the space between the ram and plunger, is filled with water. On the next upstroke of the plunger, more water is drawn into the cylinder behind it, and then in the downstroke there is no way of escape for the water filling the plunger cylinder until the pressure applied by the lever H and plunger *a* is transmitted by the water along the tube *t*, lifts the valve *r'* at the bend of this tube, and allows the water to force further through into the ram cylinder, pressing up the ram A to make room for the water below it as the plunger *a* is forced down.

When the sectional area of the ram A is 100 times the cross section of the plunger *a*, a total force of 500 lb. exerted on the plunger would lift a weight of 500 × 100, or 50,000 lb., on the ram, neglecting its own weight and the unavoidable loss by friction. At the same time the plunger must move 100 times as quickly as the ram, so that for every foot the ram is lifted the end H of the lever must be moved down 10 × 100, or 1,000 feet. By increasing the mechanical advantage of the lever, and making the cross section of the ram A very great compared with that of the plunger *a*, the hydraulic press may be constructed so that the ram will exert a total upward pressure of several hundred tons.

Now, to find the mechanical advantage of the hydraulic press, that is, the ratio of W to P, where W is the total upward pressure of the ram, or the load W in pounds it can lift, and P is the force applied at the end H of the lever.

Let A represent the cross sectional area of the ram, and *a* that of the plunger. Since the mechanical advantage of the lever is O H ÷ O F, the force of P lb. applied at H will exert on the plunger a total downward pressure of

$$P \times \frac{O\,H}{O\,F}\ \text{lb.}$$

Hence, the pressure per unit area in the water will be

$$\frac{P}{a} \times \frac{O\,H}{O\,F}$$

and this pressure is transmitted to the ram, and acts at right angles, or normal, to every part of its surface exposed to the water; so that if W represent the lifting force or total upward pressure exerted on the ram, we shall have

$$W = \frac{A}{a} \times P \times \frac{O\,H}{O\,F};$$

and therefore,

$$\frac{W}{P} = \frac{A}{a} \times \frac{O\,H}{O\,F};$$

That is,

$$\frac{\text{Load lifted}}{\text{Force applied}} = \frac{\text{Area of ram}}{\text{Area of plunger}} \times \left\{\begin{matrix}\text{Mechanical advantage}\\ \text{of lever.}\end{matrix}\right.$$

From this it is obvious that *the mechanical advantage of the hydraulic press is found by multiplying the area of cross section of the ram by the mechanical advantage of the lever, and dividing the product by the cross sectional area of the plunger.*

We must bear in mind that the plunger A must move down much more quickly than the ram rises, and the end of the handle H will go faster still. In fact the relative speed of the handle H to the ram A, usually called the *velocity ratio*, is

$$\frac{\text{Area of ram}}{\text{Area of plunger}} \times \text{Mechanical advantage of lever.}$$

Further, the efficiency is the ratio of the work done, or given out, by the machine to the work put into it; that is,

$$\frac{\text{Useful work done}}{\text{Total work expended}}.$$

From this it follows that, in the case of the hydraulic press,

$$\text{Efficiency} = \frac{W}{P \times \text{velocity ratio}}.$$

LEATHER PACKINGS.

As early as Pascal's time this principle was understood, but with high pressures it was found very difficult to prevent leakage of the water past the ram. The hydraulic press is commonly called the Bramah press, because Bramah devised the cup leather packing, C C, Fig. 7, which is let into a recess in the cylinder walls, surrounding the ram like a ring or collar, and simply yet effectually prevents leakage of water even under great pressures, and so makes the press a practically successful and useful machine. In fact, any water passing between the ram and cylinder gets behind one rim of the leather, and only goes to fill up the hollow in the leather collar, and thus presses the inner rim of the leather more and more tightly against the ram as the pressure of the water inside it increases, so that the greater the water pressure the tighter does the leather fit the ram, and prevent leakage. This cup leather collar is shown in sectional elevation and plan, C C, Fig. 8, as used in hydraulic machines. This packing may be made of leather, india-rubber, or gutta-percha. The leather is usually pressed between iron moulds into the required form, after being softened in water. After remaining several days under pressure in the mould, it keeps the proper cupped shape shown in the figures. Before being used the leather must be thoroughly soaked and lubricated, because it is found to crack at the upper part F, where the greatest friction takes place. From the illustrations we see that when this packing is fastened into the recess left for it, the water pressure in the cup-like hollow of the collar presses the flap tight against the ram.

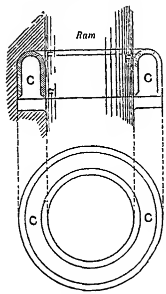


Fig. 8.

Sometimes solid india-rubber rings are used for packing, and at low pressures hemp or cotton is found very suitable instead of the leather collar, which is troublesome to replace when worn out.

The safety valve, S, Fig. 7, is usually supported by a weighted lever or spiral spring, and allows the water to escape from the plunger cylinder without entering the ram cylinder only when the pressure exceeds the limit allowed for safe working that the tubes and metal will stand without bursting.

A great variety of useful tools, devised on the above principle of the forcing-pump, such as the lifting-jack, punching-bear, riveter, and bolt-forcer, are employed when great force is required.

These are made complete in themselves, and contain the necessary water, so that by working a lever the plunger of the pump presses the water from the water-tight reservoir through an automatic lifting-valve into the cylinder containing the ram, which works the tools.

After having operated in this way, the water is allowed to return from the ram cylinder to the water-tight cistern, by means of a lowering screw.

BOTANY.—XII.

[*Continued from page* 188.]

THE FRUIT.

WE cannot give any precise or scientific definition of our ordinary use of the word fruit. Some people would hesitate to call a vegetable marrow a fruit, or might be inclined to apply the term to the petioles of rhubarb, because the one is eaten with salt, the other with sugar; and in ordinary phraseology we generally call a plum, an apple, a strawberry, a mulberry, a fig, or a pine-apple each equally a fruit, whilst we less often apply the term to a nut, a pea-pod, a poppy-head, or other dry structure. When, however, we come to examine into the structure of these different plants we find that the mulberry, fig, or pine-apple are not strictly speaking fruits at all, whilst the pea-pod or poppy-head are as truly so as the plum, and more so than the apple or strawberry.

Botanically we may define the fruit as the fertilised gynæceum of a flower together with those other adherent parts that become enlarged after fertilisation. We may distinguish those which consist solely of gynæceal structures as *true fruits*, those in which other structures are involved being more or less *pseudocarps* or false fruits. The walls of the fertilised ovary, the entire structure, that is,

of a true fruit as distinguished from the seeds which it encloses, are called the *pericarp*, and consist of three layers which are often readily distinguishable. In an unripe pea-pod, for instance, of the leaf-like character of which we have spoken before, there is a distinct outer (under) epidermis or *epicarp*, an inner (upper) one or *endocarp*, and a spongy mesophyll or *mesocarp* between them. So, too, in plums and other "stone-fruits" we have an epicarp, the "skin;" a mesocarp or *sarcocarp*, the generally fleshy and edible "pulp;" and an endocarp or *putamen*, the densely sclerenchymatous "stone," which immediately encloses the seed or "kernel." In pseudocarps the other structures contributing to the fruit are mainly derived from the floral receptacle. In the strawberry, for instance (Fig. 62, D), the numerous carpels, constituting the apocarpous polycarpellary gynæceum, are scattered spirally over a fleshy outgrowth from the conical white receptacle. No such structure is present in *Potentilla*, the buttercup, or the raspberry. In the rose the dry, apocarpous, one-seeded carpels are enclosed in a red fleshy urn-shaped receptacular tube. In the apple, the cucumber, and all fruits formed from inferior ovaries, the true fruit or gynæceum is surrounded by the adherent receptacular tube which often forms much of the fleshy portion. In the apple, for instance, the core is the true fruit: in the cucumber the veins or fibro-vascular bundles of the carpellary leaves can be seen in a cross-section forming a ring near the inner surface of the fleshy portion. The terms pericarp, epicarp, mesocarp, and endocarp cannot be properly applied to the whole of these pseudocarpic structures.

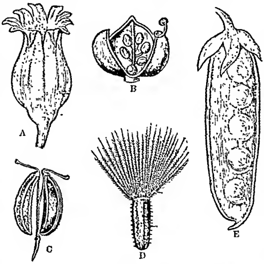


Fig. 61.—A. Capsule of Cowslip (*Primula veris*), dehiscing by teeth. B. Capsule of Rock-rose (*Helianthemum Chamæcistus*), loculicidal dehiscence. C. Cremocarp of *Pimpinella*. D. Cypsela of *Senecio*. E. Pod of Pea (*Pisum sativum*.)

After fertilisation, or even after pollination, the ovary or ovaries commonly increase in size. Whilst the petals, stamens, and sometimes the sepals fall off, nourishment is determined towards the gynæceum; and in annuals, biennials, and those other plants which, producing only one crop of flowers and fruit in their lives, are called *monocarpic*, as the fruit ripens, the whole plant withers, exhausted by the great physiological effort of seed-production. This enlargement of the ovary sometimes takes place, mainly among cultivated races of plants, without fertilisation, as in the sultana raisin, some Maltese oranges and some apples, in which cases no seed occurs. The enlarged ovary or other structures, if present, then ripen, either by drying up or withering, like autumn leaves, or by becoming fleshy. In the former case the fruit, if containing more than one seed, is commonly *dehiscent*, splitting, that is, either into one-seeded portions or *cocci* which do not themselves split, or so as to discharge its seeds. Fleshy fruits, on the other hand, are mainly *indehiscent*. They commonly change colour, turning from green to some shade of red, yellow, or, more rarely, purple, by modification of their chlorophyll, and at the same time convert much of their acid contents and protoplasm into sugar and pectose (fruit-jelly).

Some fruits are furnished, as we shall see, with wing-like projections of the pericarp and others with a pappus of hairs (Fig. 61, D) by means of which they are carried by the wind beyond the stifling shade of the parent plant. Some dehiscent fruits, such as those of the balsams (*Impatiens Noli-me-tangere* and other species), geraniums, and, to a less extent, broom (*Cytisus*) and furze (*Ulex*) split so elastically as to throw their seed some little distance. Though seed-eating birds, having strong muscular gizzards, crush all seeds that enter their stomachs, they undoubtedly scatter and drop some as they pick them out of the fruit; and they may carry them to a long distance undigested in their crops. Hawks in killing small birds frequently rip open the crop, in which way seeds in a condition capable of germination might be introduced into a new area. Fruit-eating birds, on the other hand, do not, as a rule, have muscular gizzards, and frequently swallow seeds whole and pass them undigested. A large pigeon in the Moluccas has, in this way, conveyed nutmegs from one island to another. Succulent fruits are attractive to other animals besides birds—apples, for instance, being largely eaten by deer, and their seeds are generally indigestible. Even the dry grain of grasses has been observed to be disseminated in this way, after being swallowed, by locusts.

Many fruits are furnished with recurved hooks formed from bracts or persistent styles, which become entangled in the wool or hair of animals. Migratory animals may thus convey fruits for long distances. The thick stony pericarp of some fruits offers considerable resistance to the action of sea-water, so that their seeds may sprout after travelling across wide oceans through the agency of currents. Finally, even if a succulent fruit be not eaten, it will in its decay supply its germinating seedling with moisture, if not with further nourishment.

Fruits have been variously classified and a great variety of names applied to the different forms. Many of these last we can neglect as applying only to some one exceptional type. The simple primary division of fruits into dry and succulent is often adopted; but as succulence has undoubtedly originated independently in many different groups, as have also probably the capsular and the winged condition, no classification of fruits can hope to be altogether natural. The following system is strictly morphological, taking monocarpellary fruits before polycarpellary ones, apocarpous ones before syncarpous, superior ones before inferior, and consequently leaving all pseudocarpic ones to the last, and in each group taking the dry, as the more primitive, before the succulent types. It does not profess to be an exhaustive enumeration; but most of the less common fruits that do not fall under one of its headings can be fairly described by derivative adjectival terms. The fruit of palms, for instance, differing from a drupe in being syncarpous, and in the cocoa-nut in the texture of its membranous epicarp and fibrous mesocarp, or that of the walnut, differing both in being inferior and in being syncarpous, may be called *drupaceous.*

MONOCARPELLARY.

1. Legume, ex. Pea (*Leguminosæ*).
2. Drupe, ex. Plum (*Drupaceæ*).

POLYCARPELLARY.

Apocarpous.

3. Etærio (i.) of achenes, ex. Buttercup, Strawberry, Rose; (ii.) of follicles, ex. Columbine, Larkspur, Peony; (iii) of drupels, ex. Raspberry.

Syncarpous.

Superior.

4. Caryopsis, ex. Wheat (*Gramineæ*).
5. Siliqua, ex. Wallflower (*Cruciferæ*).
6. Regma, or Superior schizocarp, ex. Mallow, *Geranium, Tropæolum, Euphorbiaceæ, Labiatæ.*
7. Samara, ex. Ash, Elm, Maple.
8. Capsule, ex. Primrose, Pink, Violet.
9. Nuculane (Superior berry), ex. Grape, Tomato, Orange.

Inferior (more or less pseudocarpic).

10. Cypsela, ex. Sunflower (*Compositæ*).
11. Nut, ex. Hazel, Oak (*Cupuliferæ*).
12. Cremocarp, or Inferior schizocarp, ex. Caraway (*Umbelliferæ*).
13. Berry, ex. Gooseberry, Banana, Prickly Pear.
14. Pepo, ex. Cucumber (*Cucurbitaceæ*).
15. Pome, ex. Apple (*Pomaceæ*).

The *legume*, or pod, the characteristic fruit of the great order *Leguminosæ*, the pea and bean tribe, is monocarpellary and one-chambered. It generally contains several ovules arranged in a single row along its ventral suture, though attached alternately to each of the two united margins (Fig. 61, E). When ripe it is dry and splits down both sutures. In *Astragalus* a longitudinal dissepiment occurs as an ingrowth from the sutures; and in other cases the legume is either constricted between each seed or is divided at these points by transverse dissepiments. It is then termed a *lomentum*, or preferably a *lomentaceous legume.*

The *drupe*, the characteristic fruit of the *Drupaceæ*, a sub-order of *Rosaceæ*, consists of one carpel, which when immature generally contains two ovules, but when ripe has commonly but one seed or "kernel." The drupe is indehiscent and its pericarp is generally divisible into three layers, the thin outer "skin" or epicarp, the thick fleshy mesocarp, and the densely sclerenchymatous "stone" or endocarp. In some cases these layers are less readily separable than in others. The epicarp may be pubescent, as in the peach; glaucous, as in the plum; glabrous, as in the nectarine; or polished, as in the cherry. Stone fruits are grown mostly for their mesocarp; but in the almond (*Amygdalus communis*), a near ally of the peach, it is the seed that has been the object of cultural selection, and the mesocarp is stringy and valueless.

Etærio (Greek ἑταῖρος, *hetairos*, a companion) is a general term for all apocarpous polycarpellary fruits. Some writers apply the term "fruit" to each carpel in this case; but it seems preferable to apply it to the whole product of a single flower. The terms *carpid* and *fruitlet* have been suggested for each carpel, and the objectionable *multiple fruit* or *syncarp* for the whole. There are three chief varieties of the etærio, differing in the character of the carpels. The *etærio of achenes* consists of a generally indefinite number of carpels, each of which is an *achene* (Greek ἀ, not; χαίνω, *chainō*, I split) or dry, indehiscent, one-seeded, and superior. Achenes do occur singly, as in *Alchemilla*, but not commonly, so we have not enumerated it with the legume. The fruit of *Ranunculus* or *Potentilla* is a typical etærio of achenes. The strawberry, as we have seen, is more pseudocarpic, the achenes being scattered over the red fleshy outgrowth from the receptacle. So too the rose, having its achenes enclosed in a fleshy but not adherent receptacular

tube, has been distinguished by the unnecessary special term *cynarrhodum*. The *etærio of follicles* more often consists of a small number of carpels, two, three, or five, arranged in a whorl or *ring*, each being a *follicle*, *i.e.*, dry, many-seeded, and dehiscing down the ventral suture only (Fig. 62, G). Thus we commonly have two or three follicles in the peony; three in the larkspur; five in the columbine; but in *Magnolia* we have an indefinite number arranged spirally. A follicle, which simply differs from a legume in splitting only down one suture, seldom occurs singly, though it does so in some peonies and larkspurs. The *etærio of drupels*, the fruit of *Rubus*, the raspberries and brambles, differs from the others in being succulent, each carpel, of which there are generally many, being a *drupel* or miniature drupe, with polished or glaucous epicarp, fleshy mesocarp, stony endocarp, and one seed, just as in the *Drupaceæ*. The drupel, however, often has a style persisting as a hook (Fig. 62, F).

The legume, drupe, and etærio being all superior, in passing to syncarpous fruits we will begin, as we have said, with those types that are superior, which also are not pseudocarpic, and among them we have five chief dry fruits and only one succulent form. The *caryopsis*, the characteristic fruit of grasses, differs mainly from an achene in being syncarpous. Some grasses, such as *Nardus*, have, in fact, only one carpel, which is, therefore, an achene; but most, as for example the wheat, have two, their line of junction marked by a groove and their styles being distinct; whilst in the bamboo there are three and consequently three grooves. In all cases alike, however, there is but one seed, and it is characteristic of grasses that this seed so entirely fills the ovarian chamber that its coats are firmly united to the pericarp, being, in fact, only separated in milling.

The *siliqua*, the characteristic fruit of *Cruciferæ*, consists almost always of two carpels, forming a two-chambered fruit, with several seeds arranged parietally, which are left, when the sides of the ripe fruit fall off as "valves," attached to the edge of the *replum* or dissepiment. A distinction was formerly drawn between the siliqua, which was long and pod-like, and the *silicula* or silicle, which was broader than it is long. The siliqua, like the legume, is commonly compressed, and a more important distinction is between those compressed at right angles to the replum (*latisept*) and those in which that partition crosses the short diameter (*angustisept*). In the radish (*Raphanus*) the siliqua is *lomentaceous*, or constricted between the seeds, with transverse septa and dehiscing in joints (Fig. 62, H).

The term *regma*, though not often used, may be conveniently applied, as a short name, for those dry superior syncarpous fruits that break up when ripe, not so as to disclose their seeds, but into their constituent carpels or half-carpels, which remain closed until the germinating seed pierces them as they decay. Such fruits are termed *schizocarps*; but this term is equally applicable to regmas, which are superior, and to cremocarps, the analogous inferior fruits. The segments into which they divide are called *cocci* (singular, *coccus*), *nutlets*, or *mericarps* (Greek μέρος, *mĕros*, a part), though the latter term has generally, but needlessly, been restricted to the halves into which the fruits of *Umbelliferæ* divide when ripe. The regma occurs in various groups of plants all of which are not very closely akin, such as the *Malvaceæ*, *Geranium*, *Tropæolum*, *Euphorbiaceæ*, *Labiatæ*, and *Boraginaceæ*. In *Malvaceæ* (Fig. 62, A), and *Euphorbiaceæ* we have a ring of carpels united before they are ripe and often indefinite in number, with hardly any carpophore or prolongation of the axis in the centre of the ring. The same is the case with *Tropæolum*, in which genus there are generally three carpels. In *Geranium*, *Pelargonium*, etc., as we have seen (p. 38), there are five carpels, the styles of which fit into grooves in the long fluted carpophore, from which they coil upwards when ripe. In *Labiatæ* and *Boraginaceæ* the two carpels divide, by the ingrowth of their midribs or dorsal sutures to join the central placentas, into four one-seeded cocci, each of which is therefore a half-carpel.

The *samara* is a fruit furnished with a wing-like outgrowth of the pericarp, which, catching in the wind, often gives it a rotary motion and may at least carry it from beneath the shade of the parent tree. This structure occurs in groups not otherwise closely related, such as the ash, elms, and maples. In the ash there is a single oblong linear wing projecting beyond the loculus or ovarian chamber. In the elm (Fig. 62, E) the wing forms an obovate flange round the loculus, ending in two hooked points (one for each carpel) above. In the maples and sycamores (Fig. 62, D, C,) the fruit is really a winged schizocarp of two, or more rarely three, carpels with a carpophore and a distinct loculus and wing to each carpel. There are also inferior *samaroid* fruits, and the student must be careful not to confuse these winged fruits with winged seeds, such as we have in firs, in which the wing is continuous with the testa.

The term *capsule* is a general one, applicable to almost all dry polycarpellary syncarpous superior fruits except those just mentioned. Capsules may be one or many-chambered, have generally many seeds, but may have parietal, central, or free-central placentation, and differ very much in their modes of dehiscence. In some few cases they dehisce *transversely*, the top coming off as a round lid, as in the pimpernel (*Anagallis*), a genus of *Primulaceæ*;

in *Plantago*, in *Hyoscyamus*, and in the Brazilian monkey-pots (*Lecythis*). This form has been termed a *pyxidium*. Other capsules are *porous*, small holes forming in the pericarp, as beneath the projecting stigmatic surface in a poppy-head, and in the monosymmetric fruits of snapdragon (*Antirrhinum*) and toad-flax (*Linaria*). Other capsules dehisce *by teeth*, the carpels splitting slightly apart at the apex, as in *Primula* (Fig. 61, A), *Dianthus*, etc. Most capsules, however, split with a *valvular* dehiscence, the side-walls or pericarp splitting longitudinally and coming away in segments known as valves. If this splitting takes place down the dorsal sutures or midribs it is called *loculicidal*, because in a many-chambered ovary, which will have central placentation, each loculus will be broken into. Each valve in this case will consist of the pericarp of two half-carpels with the seeds attached, originally, at least, to its centre (Fig. 61, B). If the splitting is along the ventral sutures it is termed *septicidal*, because with many-chambered forms having central placentation the septa or dissepiments are split, the seeds being attached to each side of the valve, the valves being each the pericarp of an entire carpel. Lastly, with either of these modes of dehiscence of the "paries" or outer wall of the capsule, the septa may be so broken across as to leave the seeds on the placentas as a free central column, as in *Datura*, the thorn-apple. This is termed *septifragal*. The inferior *capsular* fruit of *Iridaceæ* and *Campanulaceæ* has been styled a *diplotegium*.

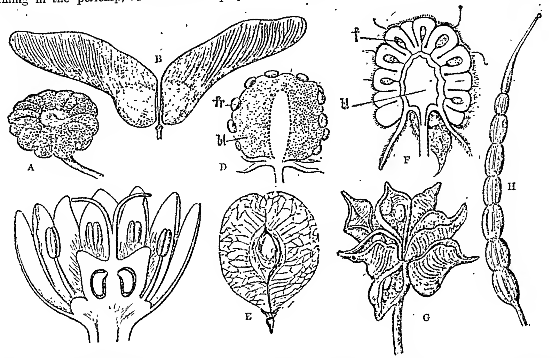


Fig. 62.—A. Regma of Mallow (*Malva sylvestris*). B. Double samara of Sycamore (*Acer Pseudoplatanus*). C. Longitudinal section of the flower of the same. D. Longitudinal section through a Strawberry (*Fragaria vesca*), *bl.* disk, *fr.* achene. E. Samara of Elm (*Ulmus*) F. Longitudinal section through etærio of drupels of Raspberry (*Rubus idæus*), *bl.* receptacle, *f.* drupel. G. Etærio of follicles in Marsh Marigold (*Caltha*). H. Lomentaceous siliqua of Radish (*Raphanus*).

The *nuculane*, or superior berry, is a fruit varying considerably in structure. The grape (*Vitis*) consists of two carpels with two seeds each on a central placenta, the fruit being actually two-chambered, with a skin or epicarp and a succulent endocarp. The structure of the fruit of the *Solanaceæ*—including the tomato, *Capsicum*, winter-cherry, bitter-sweet, etc.—is essentially similar, but the seeds are more numerous. The usually trimerous fruits of *Passifloraceæ* can generally be recognised by the gynophore separating them from the persistent calyx. The orange and the closely similar fruits of the rest of the order *Aurantiaceæ* are considerably different. They consist of a number of carpels and rest on a small circular cushion-like hypogynous disk. The epicarp, more or less separable, is yellow, leathery, and thickly studded with oil-glands. The mesocarp is white and flocculent, and the endocarp, which alone extends along the septa between the carpels, is transparent and papery. From its inner walls a number of large spindle-shaped cells forming the "pulp" are produced, which become filled with watery cell-sap

containing an orange colouring matter, citric and malic acids, etc. There are typically two seeds in each carpel.

CHEMISTRY.—VIII.

[Continued from p. 197.]

SULPHUR AND ALLOTROPIC VARIETIES—SULPHURETTED HYDROGEN—CHLORIDES, OXIDES, AND ACIDS OF SULPHUR—MANUFACTURE OF OIL OF VITRIOL—SELENIUM—TELLURIUM.

SULPHUR (S), atomic weight 32.—This element has long been known: it exists in the earth's crust, usually in volcanic regions, in the free state. It also occurs combined with many metals—as sulphides, *e.g.*, galena or sulphide of lead, PbS.; cinnabar, sulphide of mercury, HgS; blende, sulphide of zinc, ZnS, etc.—as sulphates, gypsum, calcium sulphate, $CaSO_4 + 2H_2O$, etc.—and in volcanic gases as sulphur dioxide, SO_2, and hydrogen sulphide, H_2S. Sulphur is found in various organic bodies, as oil of mustard, in the onion, in garlic, bile, in the white and yolk of eggs, etc.

Most of our sulphur is derived from Sicily and Italy; it is extracted by the simple process of melting it out of the rock in which it is found, and is usually purified by heating it until it boils, and then condensing the vapour in a suitable chamber. It occurs in commerce in sticks (roll sulphur), which are obtained by casting the melted sulphur in tubular moulds.

Sulphur, like carbon, exists in several allotropic forms:—

1. The rhombic or octahedral form (*see* Fig. 33). This is the form in which sulphur crystallises in nature, and is the most stable.

2. Prismatic variety. When some quantity of sulphur is melted in a crucible, and allowed to cool until a crust forms on the surface, if the crust be broken, and the sulphur which is still melted be poured out, the crucible will be found studded with long slender prisms of sulphur. This variety, as well as No. 1, is soluble in carbon bisulphide.

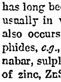


Fig. 33.

3. The plastic or elastic variety. This is insoluble in carbon disulphide, and is prepared as below.

4. Amorphous forms, *i.e.*, forms which have no definite crystalline shape, milk of sulphur, etc.

When ordinary roll sulphur is placed in a test tube and heated, it melts to a yellow liquid at 113° Cent.; at 180° Cent. this yellow liquid is somewhat suddenly converted into a viscid, semi-solid mass; the colour of the sulphur also darkens considerably; if the heating be continued, the sulphur again becomes liquid about 260° Cent., and finally boils about 440° Cent. If the melted sulphur, just before it boils, be poured in a thin stream into cold water, it solidifies as amber-coloured elastic threads, forming the plastic variety mentioned above. In time this elastic modification becomes brittle, and is converted into modification No. 1. Ordinary roll sulphur—specific gravity, 2·05 (water = 1)—is insoluble in water, and but slightly soluble in alcohol and ether; it dissolves readily in carbon bisulphide, petroleum, benzene, and chloride of sulphur (S_2Cl_2). Sulphur does not unite directly with nitrogen, but combines readily when heated with most of the other elements, as hydrogen, phosphorus, zinc, iron, copper, lead, silver, etc. Bright metallic silver when brought into contact with a body containing unoxidised sulphur, is immediately blackened, owing to the formation of sulphide of silver. Silver spoons are thus blackened by the yolk of an egg, and by exposure to the atmosphere of towns which burn gas and coal.

Hydrogen Sulphide, or Sulphuretted Hydrogen (H_2S).—This colourless gas is most conveniently prepared by acting upon fragments of ferrous sulphide (6d. per lb.) with dilute hydrochloric acid; the hydrogen apparatus (Fig. 5) can be employed—

$$FeS + 2HCl = H_2S + \underbrace{FeCl_2}_{\text{Ferrous chloride.}}$$

This gas should be collected over warm water, as cold water dissolves three to four times its volume of hydrogen sulphide. It burns with a blue flame, forming SO_2, H_2O, and S; it has a very unpleasant odour and sweetish taste; it is very poisonous; in cases of poisoning it is best to remove the patient at once into fresh air. Hydrogen sulphide is destroyed by chlorine—

$$H_2S + 2Cl = 2HCl + S,$$

but as chlorine is itself poisonous, this reaction cannot be utilised when hydrogen sulphide has been taken into the lungs. This gas can be condensed to a colourless liquid at a pressure of 17 atmospheres at 10° Cent. Hydrogen sulphide, both as a gas and in solution in water, is a most valuable reagent or test in the laboratory; it precipitates many of the metals from their solutions as sulphides, some from solutions containing hydrochloric acid, and some only when their solutions are neutral or alkaline. Thus the following metals are precipitated as sulphides from an acid solution:—Bismuth, copper, lead, mercury, silver, and tin (stannous salts) as black or brown precipitates; cadmium, arsenic, and tin (stannic) as yellow precipitates; and antimony as an orange precipitate;

while iron, cobalt, and nickel (black), zinc (white), and manganese (flesh colour) are only precipitated when the solution is neutral or alkaline. The presence of hydrogen sulphide is easily detected by its odour, or by a piece of paper moistened with lead acetate solution, which is turned brown or black.

Chlorides of Sulphur.—When dry chlorine is passed over melted sulphur, a vapour is obtained which condenses to a clear yellow liquid with an irritating odour; this is *monochloride of sulphur*, S_2Cl_2. It has the property of dissolving sulphur readily; the solution is used for vulcanising india-rubber. Ordinary india-rubber in warm climates becomes sticky and unusable; but if a small quantity of sulphur be mixed with it, and the mixture heated, the two combine, forming vulcanised india-rubber, which does not become sticky, and at the same time retains its elasticity. If too much sulphur be added, the hard non-elastic vulcanite is formed. Two other chlorides—SCl_2 and SCl_4—are known.

Oxides and Acids of Sulphur.—There are two stable oxides and eight acids of sulphur:—Sulphur dioxide, SO_2; sulphur trioxide, SO_3; hyposulphurous (formerly called hydrosulphurous) acid, H_2SO_2; sulphurous acid, H_2SO_3; sulphuric acid, H_2SO_4; thiosulphuric (formerly called hyposulphurous) acid, $H_2S_2O_3$; dithionic $H_2S_2O_6$, trithionic $H_2S_3O_6$, tetrathionic $H_2S_4O_6$, and pentathionic $H_2S_5O_6$, acids. It is particularly unfortunate that two of these acids, H_2SO_2 and $H_2S_2O_3$, should have been called hyposulphurous acid. In all modern textbooks $H_2S_2O_3$ is called thiosulphuric acid; but its most common sodium salt is invariably termed in commerce "hyposulphite of soda." Oxides S_2O_3 and S_2O_7 also appear to exist, but are unstable, as well as an acid—persulphuric acid, HSO_4.

Sulphur Dioxide, or Sulphurous Anhydride (SO_2). —This colourless gas is always produced when sulphur burns in oxygen; it is most conveniently prepared by heating sulphuric acid with copper turnings or clippings in a flask furnished with cork and delivery tube—

$$Cu + 2H_2SO_4 = \underbrace{CuSO_4}_{\text{Copper sulphate.}} + SO_2 + 2H_2O.$$

The gas must be collected over mercury, or by downward displacement, since cold water dissolves about 80 times its volume of the gas. Instead of copper, mercury, sulphur, or carbon can be used to decompose the sulphuric acid. Sulphur dioxide is a colourless, heavy, irrespirable gas; specific gravity $= 32$ ($H = 1$). It has the characteristic odour of burning sulphur. It is easily liquefied at a temperature of $-10°$ Cent., or at a pressure of two atmospheres at ordinary temperatures. It does not support ordinary combustion; it absorbs oxygen from many substances, and so is called a reducing agent; thus, when added to a solution of gold, it precipitates the gold as a metallic powder. Sulphur dioxide bleaches, and is usually employed in bleaching wool, flannel, silk, and straw, substances which would be injuriously affected by chlorine. It is also one of our most useful and powerful disinfectants and antiseptics. The burning of a large sulphur match is a common method of disinfecting a room, sweetening a cask, etc. When this gas is dissolved in water, a solution of sulphurous acid, H_2SO_3, is produced. This acid forms with the metallic oxides an extensive series of salts called sulphites; these all give off sulphur dioxide when heated with dilute acids. If some fragments of zinc be added to sulphurous acid the metal dissolves without effervescence, forming hyposulphurous—or, as it used to be termed, hydrosulphurous—acid, H_2SO_2—

$$H_2SO_3 + H_2 = H_2SO_2 + H_2O.$$

Sulphur Trioxide, or Sulphuric Anhydride (SO_3). —This substance is obtained as colourless silky needles by passing a mixture of sulphur dioxide and oxygen over heated, finely divided (spongy) platinum, $SO_2 + O = SO_3$. It can also be prepared by distilling a mixture of strong sulphuric acid with phosphorus pentoxide, P_2O_5. Sulphur trioxide combines violently with water, and gives out much heat, forming sulphuric acid, H_2SO_4.

Sulphuric Acid—Oil of Vitriol (H_2SO_4).—This is the most important chemical product manufactured; and since the quantity of chemicals used by a country gives a rough estimate of its progress, it has been stated that the commercial prosperity of a country can be gauged by the amount of sulphuric acid which it consumes. Sulphuric acid is used in nearly every chemical manufacture; as examples, we may mention washing soda (so largely employed in glass- and soap-making), chlorine (for bleaching powder), phosphorus (for matches), nitric acid, etc.

The method now used for the manufacture of sulphuric acid originated about 1790. The substances from which sulphuric acid is made are sulphur dioxide, water, ordinary air, and nitric acid vapour; the substances which result are dilute sulphuric acid, nitrogen, and peroxide of nitrogen, NO_2. Sulphur dioxide is incapable of rapidly absorbing oxygen from the air, but in the presence of water it can absorb oxygen from nitrogen peroxide, NO_2, reducing it to colourless nitric oxide, NO. The latter substance is capable of absorbing oxygen from the air and re-forming the orange-red NO_2; so in the presence of a large quantity of sulphur dioxide, air, and water, a comparatively minute quantity of nitrogen peroxide acts as a carrier,

taking up oxygen from the air and delivering it to the sulphur dioxide, which is thereby oxidised, and in the presence of water converted into sulphuric acid. Some believe that the nitric oxide is converted into N_2O_3 and not into NO_2, but in either case the reaction is essentially the same.

The sulphur dioxide is obtained by burning iron pyrites or sulphur in furnaces; the gas thus pro-

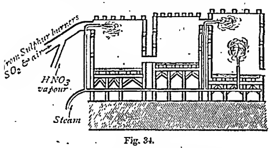


Fig. 34.

duced passes, mixed with a large quantity of air, into a series of enormous chambers (Fig. 34), made of sheet lead—lead being the only practicable metal which resists the action of the sulphuric acid; these chambers may be 100 feet long by 20 feet broad, and 15 feet high, they are supported outside by timber framing; the joints of the lead must be united by melting in pure lead with the aid of the oxyhydrogen blowpipe, as ordinary solder (tin and lead) would be acted on by the acid. Into these leaden chambers are also introduced the nitric acid vapour and the water in the form of steam or finely divided spray. The nitric acid vapour is at once reduced to nitric oxide—

$$(1)\ 3SO_2 + 2HNO_3 + 2H_2O = 3H_2SO_4 + 2NO,$$

which in its turn absorbs oxygen from the air—

$$(2)\ NO + O = NO_2;$$

the nitric peroxide oxidises another molecule of sulphur dioxide—

$$(3)\ NO_2 + SO_2 + H_2O = H_2SO_4 + NO.$$

Reaction number two then follows, then number three, and so on, until all the sulphur dioxide is converted into sulphuric acid. The gases which are left consist of nitrogen (from the air), with a little oxygen and nitrogen peroxide; the nitrogen and oxygen are allowed to escape, but in all modern works the nitrogen peroxide is absorbed by passing the escaping gases over a surface of strong sulphuric acid; when the strong acid, which has absorbed the nitrogen peroxide, is diluted, the nitrogen peroxide is evolved and passes in with a fresh quantity of sulphur dioxide, so that the same nitrogen peroxide is used over and over again.

The acid, which is drawn off from the chambers, contains about 65 per cent. of H_2SO_4, the rest being water; it is known as "chamber acid." This is further concentrated by boiling down in leaden dishes until it contains 78 per cent. of H_2SO_4, when it is known as brown oil of vitriol or B.O.V. If the boiling be continued after this strength has been attained, the acid will dissolve the lead rapidly, so further concentration has to be effected in glass or platinum vessels, when an acid of 98 per cent. can be obtained. Ordinary oil of vitriol always contains in solution sulphate of lead, which renders the acid milky when water is added, and eventually settles as a white precipitate; the ordinary acid usually contains also arsenic. Pure sulphuric acid is a colourless oily fluid, specific gravity 1·84, it has a great affinity for water, and thus decomposes and chars many organic substances. When sulphuric acid is added to water, great heat is produced; so that sulphuric acid should never be added to hot water, nor water to strong sulphuric acid. If strong sulphuric acid should by any chance come into contact with the skin, it should be washed away by the sudden application of *large* quantities of cold water, and then any remaining acid neutralised by a weak solution of sodium carbonate. Strong sulphuric acid is much used in the laboratory for drying gases. It combines with many metallic oxides, forming sulphates, which usually crystallise well, and are mostly soluble in water; the principal exceptions being the sulphates of lead, barium, and strontium. The solution of a sulphate gives a white precipitate with barium chloride, which is insoluble in hydrochloric acid.

Nordhausen or Fuming Sulphuric Acid ($H_2S_2O_7$).—This fuming liquid is prepared by distilling dried ferrous sulphate (green vitriol). It closely resembles ordinary sulphuric acid, but it fumes in the air; it is used for dissolving indigo, in the preparation of artificial alizarin (the colouring matter of the madder plant), etc.

Thiosulphuric or Hyposulphurous Acid ($H_2S_2O_3$).—This acid has not been prepared, but its sodium salt, sodium thiosulphate or, as it is always termed in commerce, "hyposulphite of soda," is used largely in photography as a fixer, *i.e.*, it fixes or renders permanent the photographic image by dissolving out the silver bromide or chloride which has not been exposed to the light. Sodium thiosulphate can be prepared by boiling sulphur with sodium sulphite solution

$$S + Na_2SO_3 = Na_2S_2O_3.$$

A solution of this salt dissolves silver chloride, bromide, and iodide readily, forming a double sodium silver thiosulphate, $NaAgS_2O_3$, which is soluble in water.

Selenium (Se), atomic weight 79.—This element was discovered in 1817 by Berzelius in some red deposits found in sulphuric acid chambers. There are three allotropic forms of selenium (1) a red powder; (2) a black crystalline form; and (3) a form insoluble in carbon bisulphide, which is obtained by heating ordinary selenium for some time to 210° Cent. till it solidifies to a granular crystalline mass.

Tellurium (Te), atomic weight 125, was discovered in 1782; it occurs combined with gold, silver, bismuth, etc. It is a bluish-white solid, with a metallic lustre, specific gravity 6·4 (water = 1). It is insoluble in water and in carbon bisulphide.

Sulphur, selenium, and tellurium form a group of closely allied elements; they all burn with bluish flames, producing the oxides SO_2, SeO_2, and TeO_2; they form colourless gases with hydrogen, H_2S, H_2Se, H_2Te, which have offensive odours, and precipitate many metallic solutions. They form, with the exception of selenium, two oxides and two acids, which have similar properties. It is also noticeable that the atomic weight of selenium is nearly the mean between that of sulphur and tellurium—thus S 32 + Te 125 $= \frac{157}{2} = 78·5$ (Se = 79). A similar relation occurs in the halogen group—chlorine, bromine, and iodine $\frac{35·5 + 127}{2} = 81·2$ (Br = 80).

LATIN.—XXIII.

[*Continued from p. 202.*]

EXERCISE.

In a philosopher I should not disparage eloquence if he had it to offer; if he had it not, I should not clamour for it. I shall willingly agree with you if you prove to me what you say. If that alone were pleasure which flowed into the senses, so to say, with an attendant feeling of sweetness, no part of our body would be contented by mere freedom from pain without a pleasant sensation as well. But if, as Epicurus maintains, the highest pleasure is to have no pain, the first of your concessions was right—that when the hand was thus affected, it felt no want. If a life full of pain is above all things to be avoided, assuredly it is the greatest evil to live in pain. "Who would think virtue desirable," says Epicurus, "unless it caused pleasure?" Assuredly they would not have done so if they had thought that it did not concern them at all. If I were to deny that I am influenced by regret for my friend, I should certainly be lying. If it is true that the soul of the best of men flies away most easily in the moment of death from the custody and fetters of the body, who can we suppose to have had an easier voyage to heaven than Scipio? He would never have wished such a thing, but if he had, I should have obeyed. If he wished him to set fire to the temples, he would think he ought to do it. It is difficult for friendship to be maintained if you fail in virtue. If you are wont to admire my wisdom (I would it were worthy of your good opinion!), it consists in following and obeying nature—the best of guides—as divine. You will do what is most pleasing to us if you tell us this first. I will certainly do so, especially if, as you say, it will oblige you both. If you had not lost it, I should never have recovered it. If that were true, it would blot out every hope. You must believe that I am still the same, even if you see me not. If this were not so, no one would strive for the fame of victory.

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§ 27. (6) CONCESSIVE AND COMPARATIVE CLAUSES.

We need not stay long over the remaining kinds of adverbial clauses. They illustrate clearly the difference of meaning between the indicative and the subjunctive moods, and are closely akin to the conditional clauses which we have just discussed at length.

Apart from special idioms—to some of which attention is directed below—the general distinction holds, viz., that if the concession, contrast, comparison, limitation, is regarded or ***stated as a fact or reality***, the ***indicative*** is used; if it is regarded or ***stated as imaginary***, as a mere conception, the ***subjunctive*** is used. (Of course, the subjunctive is also always used in *Oratio Obliqua*.)

The chief concessive conjunctions (so called because they make some ***concession*** or admission, in spite of which the statement in the main clause remains true) are *etsi, etiamsi, tametsi; quamquam, quamvis, licet: cum* (= "although"), and *qui* (the relative). The contrast or opposition referred to is often marked and emphasised by other words, *e.g.*, *tamen* in the principal clause.

The compounds of *si* are used precisely as *si* is in conditional clauses.

Quamquam is almost invariably found with the INDICATIVE; and *quamvis, licet, cum*, and *qui*, equally invariably with the SUBJUNCTIVE.

Quamvis is often found with a single word (adjective) without a verb.

The chief comparative conjunctions (expressing ***likeness***, etc., or the opposite, to the statement made in the main clause) are *atque* (*ac*), *quam, ut, velut, quasi, velut si, tamquam* (*si*), *quemadmodum*; they are constantly led up to or emphasised by

corresponding demonstrative adverbs, such as *aeque*, *pariter*, *aliter*, *secus*, *potius*, *ita*, *sic*.

EXERCISE.

Although he was suddenly snatched away from us, he lives and always will live in my memory. However bold he may be, he would not dare to do that. Although the soldiers were worn out by forced marches, they eagerly demanded battle. However wise you may be, you will not conquer him. Do it as suddenly as you like, you will not surprise him. Although the attempt was not successful, yet it is worthy of the highest praise. Though I die, I will say so! He behaved as though he was mad. He acted quite differently from what I expected. He is equally guilty in reality, as if he had been the cause of all our troubles. He will be punished as though he were your father's murderer. I was as much alarmed as if I had fallen into the midst of the flames of civil strife. Never in my life have I derived such pleasure from anything as from this honesty; and the fame it brings, great though it is, does not delight me as much as the honesty itself. Things which we cherish in our hearts are no less ours than those which we look on with our eyes; and no greater friend than I am could succeed you. Although I found the business begun in a quite different fashion from that which I should have approved of had I been present, all the same I did what I had promised. Be sure that you are not more anxious than I am that your departure from me should be as fruitful as possible to you.

ORATIO OBLIQUA.

In discussing the syntax, we gave you in outline the chief rules for transferring *Oratio Recta* into *Oratio Obliqua*. It is necessary, however, to treat the subject systematically, and at greater length, so that we shall recapitulate and expand what we have said above.

§ 28. We have now passed in review some of the chief varieties of principal sentences and of subordinate sentences, and are in a position to consider more fully the constructions used in Latin in *Oratio Obliqua*. Some of the most important laws for regulating the expression of subordinate sentences in *Oratio Obliqua* or *Virtual Oratio Obliqua* we have already noticed, in particular the constant use of the subjunctive mood; but the following rules will set the whole usage in a clearer light.

We must distinguish between (1) principal sentences, and (2) subordinate sentences.

And, further, we must distinguish as to (i.) mood, and (ii.) tense, all the persons of *Recta* being represented by the *third* in *Obliqua* (except that the first person is kept when the speaker is reporting his own words).

(1) PRINCIPAL SENTENCES are of three kinds—

(*a*) Statements.

(*b*) Questions.

(*c*) Commands.

(*a*) *Statements*, whether they occur in the indicative or the subjunctive in *Oratio Recta*, are always in the *infinitive* in *Oratio Obliqua*. The tense is present, past, or future, according as the tense of the original verb of *Oratio Recta* was present, past, or future.

(*b*) *Questions* which are closely dependent on a verb of asking, or deliberative questions—which in *Oratio Recta* would be in the subjunctive—are put in the subjunctive in *Oratio Obliqua*. Other questions are put either in the subjunctive or the infinitive:—(i.) Questions which in *Oratio Recta* are addressed to *the first* or *third* person (usually rhetorical questions to which no answer is expected), are expressed by the *infinitive* in *Oratio Obliqua*; (ii.) Questions addressed to the *second person* are put in a *secondary tense* of the *subjunctive*. To these rules there are occasional exceptions.

(*c*) *Commands*, whether in the imperative or the subjunctive in *Oratio Recta*, are in the subjunctive in *Oratio Obliqua*; and the tense is almost always secondary.

(2) SUBORDINATE SENTENCES, whether in the indicative or the subjunctive in *Oratio Recta*, are in the subjunctive in *Oratio Obliqua*: the tense being usually secondary.

For the sake of vividness, especially if the verb introducing the *Oratio Obliqua* be in the present tense, the present and perfect tenses of the subjunctive are sometimes used in subordinate sentences (but rarely in questions and commands).

The following table gives a view of the correspondence of moods and tenses between *Oratio Recta* and *Oratio Obliqua*:—

Oratio Recta.		*Oratio Obliqua.*	
		Mood.	*Tense.*
Statements	Indicative. Subjunctive.	Infin.	Same.
Questions	Subj. and Ind. 2nd person.	Subj.	Usually secondary.
	Ind. 1st & 3rd pers.	Infin.	Same.
Commands	Imperative. Subjunctive.	Subj.	Usually secondary.
Subordn. Sentences	Indicative. Subjunctive.	Subj	Usually secondary.

TRANSLATION.—VERGIL.

We propose now to give you for translation some passages from the greatest of Latin poems—the "Æneid" of Vergil. It is impossible for you to read through this work, which is divided into twelve

books, each containing on the average about 800 lines; but we may, by selecting some of the best parts, give you a fair idea of the scope and grandeur of the whole. For this purpose we shall give you some introductory information concerning the poet and his work, his object in writing, and the conditions under which he wrote; for otherwise, isolated passages can scarcely be understood.

Vergil, who was born at Mantua in 70 B.C., lived at the time when the Roman Empire—after being rent by divisions, and almost ruined by misgovernment—was settling down to peace and prosperity under the rule of Augustus. Although it would be misleading and unfair to describe Vergil as a Court poet, he wrote under the favour and protection of the Emperor and his minister Maecenas; and it is probable that the "Æneid" (like his earlier work, the "Georgics"), was written at the suggestion of his patrons. The "Æneid" of Vergil was to the Romans what the "Iliad" and "Odyssey" were to the Greeks—the great national epic. It contains the history of Æneas, the national hero, and the father of the Roman race; it tells the story of his escape from Troy, of his wanderings by sea and land, and finally of his conquest of Latium, the district in Italy where Roman history began. In the plan of his work, Vergil is obviously imitating Homer. You must remember that the Latins had no literature until they came into contact with the Greeks; that the first Latin writers translated Greek poems, or wrote on Greek models; and that Latin literature in all periods was imitative. Hence it was natural for Vergil to imitate Homer's work, to make his characters similar to those of Homer, to adapt complete incidents from Homer, and even to translate passages at length from Homer, or other Greek poets. Thus Æneas, the hero of Vergil's poem, corresponds partly to Odysseus, the hero of the "Odyssey"; partly to Achilles, the hero of the "Iliad." We have in the first book of the "Æneid" an account of the wanderings of Æneas until he is cast on the shores of Carthage, where he falls in with Dido, the queen of the country, and is entertained by her. In the second and third books, he relates to Dido the story of the fall of Troy, just as Odysseus does in the "Odyssey"; the fifth book, which is taken up with the games held in honour of Anchises, is suggested by the book of the "Iliad" concerning the games in honour of Patroclus. In the sixth book, Æneas, like Odysseus, descends to the land of shadows, and meets the spirits of departed heroes. Of the other books, the fourth is occupied with the love story of Æneas and Dido; and the last six books deal with the conquest of Latium by Æneas. Such is the outline of the events described in the poem.

Now let us consider what was the purpose with which the "Æneid" was written, and the great ideas underlying the poem. Vergil, although he took Homer as his model, added much that was his own, and in the "Æneid" we must probably recognise a great patriotic purpose. The "Æneid," as Professor Nettleship has said, has for its main purpose the celebration of the growth, under Providence, of the Roman Empire, and of Roman civilisation. It stands at the end of one period of history and at the beginning of another, and expresses pride in the past and faith in the future of the Eternal City. Æneas sums up in himself the great qualities of the Roman nation in its conquest of the world—great in war, great as a ruler and a civiliser of men. The spread of Roman arms and arts over the world, which had in Vergil's time been almost completed, is typically described by the poet in the conquest of the barbarous tribes of Latium by Æneas, and the introduction of peace and civilisation into Italy.

We will now give you for translation a passage from the beginning of the "Æneid," which contains some of the most familiar lines of Latin poetry. The first and fourth books, as you have just learnt, describe the adventures of Æneas at Carthage, his love for Queen Dido, and his desertion of her in obedience to the will of the gods. Critics have thought that this narrative foreshadows in legendary form the greatest event of Roman history—the conflict of Rome with Carthage. This is represented in epic form by representing the goddess Juno as the champion of Carthage and the enemy of Æneas. The poem begins with a preface describing the subject of the poem, and an invocation to the Muse to inspire the poet:—

Arma virumque cano, Trojae qui primus ab oris
Italiam, fato profugus, Laviniaque venit
Litora; multum ille et terris jactatus et alto
Vi superum, saevae memorem Junonis ob iram;
Multa quoque et bello passus, dum conderet urbem,
Inferretque deos Latio; genus unde Latinum,
Albanique patres, atque altae moenia Romae.
Musa, mihi causas memora, quo numine laeso
Quidve dolens, regina deum tot volvere casus
Insignem pietate virum, tot adire labores
Inpulerit. Tantaene animis coelestibus irae!
Urbs antiqua fuit (Tyrii tenuere coloni),
Carthago, Italiam contra Tiberinaque longe
Ostia, dives opum, studiisque asperrima belli;
Quam Juno fertur terris magis omnibus unam
Posthabita coluisse Samo. Hic illius arma,
Hic currus fuit: hoc regnum dea gentibus esse,
Si qua fata sinant, jam tum tenditque fovetque.

Progeniem sed enim Trojano a sanguine duci
Audierat, Tyrias olim quae verteret arces;
Hinc populum late regem belloque superbum
Venturum excidio Libyae: sic volvere Parcas.
Id metuens, veterisque memor Saturnia belli,
Prima quod ad Trojam pro caris gesserat Argis;
(Necdum etiam causae irarum saevique dolores
Exciderant animo: manet alta mente repostum
Judicium Paridis spretaeque injuria formae,
Et genus invisum, et rapti Ganymedis honores):
His accensa super, jactatos aequore toto
Troas, reliquias Danaum atque immitis Achilli,
Arcebat longe Latio; multosque per annos
Errabant, acti fatis, maria omnia circum.
Tantae molis erat Romanam condere gentem.

NOTES.

1. *Arma virumque cano.* "I sing of battles and that hero." *Arma* is used figuratively *for bella; virum* is, of course, Æneas.

2. *Italiam* and *litora* are both accusatives of the *place to which*, which in prose would require a preposition.

Lavinia litora = Latium. Lavinium was a city of Latium, which, according to the legend, was named after Lavinia, the bride of Æneas.

3. *Jactatus.* "Much tossed both by land and sea." *Terris* and *alto* are oblatives of place.

4. *Superum* = "the powers above;" *i.e.*, the gods. Notice the old form of the genitive plural in *-um* instead of *-orum*; cf. *Danaum*, in l. 30.

5. *Dum conderet.* *Dum* ("whilst") with the subjunctive expresses purpose. These lines describe the subject of the poem—the foundation of Rome, the institution of the Roman religion, and the origin of the Latin race.

7. *Albani patres.* Alba Longa was at one time the chief city in Latium. Here the Trojans were said to have originally settled, and from it Rome was supposed to have been founded.

8. *Musa.* The "Iliad" also begins with an invocation to the Muse.

Quo numine laeso, ablative absolute. *Numen* is a word difficult to translate in English. It means the will or purpose of a divinity, or sometimes the actual divinity. Here the reference seems to be to the injury to Juno: "What attribute of divinity was hurt."

9. *Regina deûm.* Juno.

Volvere. Literally, "to roll"—*i.e.*, "to go through," "to turn the wheel of" (Conington).

10. *Insignem pietate.* The stock epithet applied to Æneas is *pius*, a word corresponding in sense to our word *dutiful; pietas* implies duty in any relation—duty of a son to a father, or of a citizen to his fatherland.

12. *Tyrii coloni*, "settlers from Tyre." Carthage was a Phœnician colony.

13. *Contra* governs both *Italiam* and *ostia*. Translate—"At a great distance opposite to Italy and the Tiber's mouth." At the mouth of the Tiber lay Ostia, the port of Rome.

14. *Dives opum.* Adjectives denoting *plenty* are sometimes found with the genitive, more often with the ablative.

Asperrima. Literally, "very rough"—*i.e.*, "very fierce," "bold."

15. *Unam*, "which one city (above all others)." *Unus* is often used to intensify a superlative, it is more rarely found with a comparative.

16. *Posthabita Samo.* "Samos being placed behind"—*i.e.*, less esteemed. Samos was a great seat of the worship of Hera (Juno). The whole being equivalent to *not excepting Samos.*

17. *Hoc regnum esse gentibus* forms one idea governed by *tendit foretque.*

20. *Olim*, which generally refers to past time, here refers to the future.

21. *Hinc populum*, etc. Accusative and infinitive in *Oratio Obliqua*, giving the thought in Juno's mind.

22. *Libyae.* The north of Africa, in which Carthage was situated.

Volvere Parcas. "That so the Fates guided (*lit.*, rolled events)." *Parcae* is a Latin title for the three Fates.

23. *Saturnia.* "Daughter of Saturn." Juno and Jupiter were said to be children of Saturn.

24. *Prima.* "She first" = "chiefly."

Argis. Argos was sacred to Juno (or Hera as she was called by the Greeks). The Argives were the leaders of the Greeks whose part Juno took in the Trojan war, because the judgment of Paris (l. 27) had awarded the palm of beauty to Venus.

27. *Spretae injuria formae.* Lit., "The wrong of the despised beauty"—*i.e.*, "the wrong done her in spurning her beauty"—refers to the choice of Paris.

28. *Genus invisum*—*i.e.*, the Trojans.

29. *His accensa super* sums up the causes of Juno's wrath, enumerated in the six preceding lines. *Super* is probably the preposition governing *his*, although it is out of place. It might be an adverb = *insuper*, "besides."

30. *Reliquias.* Lit., "the remnant" = "those who had been left alive by the Danai." *Danaum*, another name for the Greeks.

33. *Tantae molis erat.* "It was (a task) of such great difficulty to found the Roman race." This strikes the keynote of the poem, the foundation of the Roman Empire.

KEY TO EXERCISES.

p. 198.

Omnia quae sibi erant mihi dedit. Qui sapientiam habeant divites sunt (qui . . habent = *the definite persons who*). Is est qui mihi librum dedit. Te amo quia bonus es. Nunquam discedere volat, quia non hic relicturus sit (*as he would say to himself*). Una res quae nobis nunquam deficere potest exstat virtus. Neminem adesse qui se intelligeret dixit. Quae cuperet ille me daturum esse sum pollicitus. Negavi, quia ea quae cuperem mihi dare nollent (*as I thought*). Multi ea tantum quibus ipsi non egent aliis dant. Irascuntur quidam quia se haud satis laudent homines.

p. 199.

Cum locus, ubi in sicco fessa sternerent corpora, nullus inveniri posset, cumulatis in aqua sarcinis insuper incumbebant. Ipse Hannibal elephanto, qui unus superfuerat, quo altius ab aqua exstaret, vectus est. Majore conatu atque impetu res acta quam prioribus est annis, quia spem posse vinci hostem dictator praebuerat. Dixit ignes in parte castrorum, quae vergat ad hostem, relictos (esse). Forte ita evenit, ut servi duo qui excepti a Numidis fuerant, ad dominos eo die profugerent. Opto ut omnia prospere eveniant. Ita sunt castra facta, ut procul ab hostibus esset omne robur virium. Fabius litteris et ipse et collega ejus acciti sunt, ut exercitus

ab se acciperent. In Siciliam progressi sunt, ne Romani ceteros equites in Italiam reducerent. Mille et quingentos milites, quos secum habebat, Romam, ut urbi praesidio essent, mittit (*historic present = perfect*). Ad oppidum pergunt ire, quod ibi obsides totius Africae Scipioni traditos fama erat modico in arce custodiri praesidio. Iratus erat imperator, quod milites quae imperasset facere nollent. Ne tanto in discrimine abesset, neve socios antiquos desereret, protinus ad templum iter intendit. Quo pronior esset in pugnam, agitare eum atque irritare parat. Ne quid mali ageret, in custodia habebatur, ut reginam non videret. Cum me manere jubeas, non potest fieri ut abeam. Restat ut te valde moneam ne id facias. Dabo operam ut illi persuadeam ne solus diutius maneat. Moneo te illum non adfuturum esse.

p. 200.

Accidit decimo ante die quam abiisti. Domi manebo, dum redieris. Negabant illum prius ad exercitum mittendum quam consulem in locum Fabii suffecisset. Ne in senatu quidem audiebatur, cum hostem verbis extolleret. Minucius vero, cum jam ante vix tolerabilis fuisset, tum quasi jam victo Hannibale aperte gloriatur. Postremo, cum hostibus quoque subsidia mitti videret, instructis legionibus procedit. Priusquam manum consereret, et suos a fuga et a saevo impetu hostes continuit. Dum imperare discimus, sapientioribus pareamus. Postquam ab ea parte satis tutam insulam censebat consul, ad Rhegium, quia fama erat stare ibi Punicam classem, trajecit. Cum sic affectos dimisisset, contione inde advocata ita apud eos locutus (esse) fertur. Cum instare certamen cerneret, vocatis in praetorium magna praemia pronuntiat. Prius Arretium pervenere, quam a Pado profectos satis sciret imperator. Dum loca omnia castrorum perscrutantes tempus terant, hostis de manibus emissus est. Postquam nulla spes vincendi erat, signum receptui dedit. Vixdum profecto occurrit pater. Ea res ubi palam facta est, omnibus iram movit. Ubi primum illuxit, proelium uno animo et voce una poscunt. Adhuc pauper eris dum vivet frater. Num expectas dum mortuus sit (*or* moriatur)?

HISTORIC SKETCHES, GENERAL.—III.

[*Continued from p.* 210.]

THE JEWS.

So intimately is the history of the Jews bound up with the Holy Scripture narrative, that few persons accustom themselves to regard the two as distinct. In one sense, of course, they are not distinct. The Jewish history, like the rest of the Old Testament, was written for our learning, and is profitable for "instruction in righteousness."

It is the very groundwork, so to speak, of the Bible. Yet is it well sometimes to consider the remarkable history of this remarkable people apart from its surroundings, to learn from it the meaning of its intense individuality, and to see that had no more been patent to the world than the marvellous series of facts from the delivery out of Egypt to the establishment of Saul upon the throne, men must have been led to the conclusion that some special providence watched over the national life of the Jews, and that the Jews were a chosen people, specially favoured of the Divine Ruler of the universe. Most of the earlier Jewish history is derived from the Bible, but the later portions are drawn from many sources—from the histories of people who made a great figure in the world till they bruised themselves against the rock of Jewish nationality, and were overthrown by it—from the histories of peoples who finally dispossessed the chosen people, and cast them forth as wanderers upon the face of the earth. It is proposed in this sketch to portray the Jews as they appeared at distinct epochs in their history, with a view to directing attention to the special features of their case, and to induce our readers to pursue more closely for themselves the study of the most remarkable history known to the experience of the world.

"And all the people shouted and said, God save the king." It was a new cry in Israel. Up to that time the Jews had been content to live under the political guidance of spiritual chiefs, acting for and in behalf of that Divine Ruler who had brought them out of Egypt with a mighty hand and a stretched-out arm. Now they wearied of the unseen King who never held courts, nor entertained, nor showed Himself, save in a figurative way, but who yet kept awful state in the midst of the people, being made manifest sometimes in the storm, sometimes in the whirlwind, and to those few who could understand Him in that guise, in the still small voice. So "Samuel took a vial of oil, and poured it upon Saul's head, and kissed him, and said, Is it not because the Lord hath anointed thee to be captain over His inheritance?" and at Mizpeh Samuel collected the people and announced what he had done, reproaching them at the same time for having rejected the God "who Himself saved you out of all your adversities and your tribulations," and for having said, "Nay, but set a king over us." Saul was anointed, the multitude shouted "God save the king," and the first step was taken towards divorcing the State, not from the Church merely, but from the Head of the Church, from God Himself.

Those who may have noticed it as a curious thing, when reading the historical books of the Old Testament, that the functions of the prophet should have been allowed to clash with the functions of the king, and that what must often have looked like insolence was tolerated, in appearance at least, when it came from the mouth of a man of God, would do well to call to mind the peculiar relationship in which prophet and king stood to each other. Historically considered, the prophet was the creator of the king, the ruler who had governed before ever the idea of monarchical government had entered the mind of the Jewish leaders—the man who, having given, might be supposed to have some power also to take away. The prophet

was the avowed oracle of God; the king was a concession to the desire of the people—a desire which was expressed in direct contravention of the will of the Almighty. The Israelitish people could not remain satisfied with a system of government which differed in so remarkable a manner from that of the nations by whom they were surrounded, and, in spite of Samuel's urgent advice, they persisted in asking for a king. Still it must be borne in mind that, in spite of this change, the principles of government which prevailed among the Israelites from the time they came out of Egypt to the period when they ceased to be a collective nation, were those of a pure theocracy—that is, of a form of government in which God is the central figure, the head from which all orders emanate, and to whom all accounts of orders executed are rendered. As the representative of God, and the exponent of His word, a prophet was to be obeyed implicitly whenever he spoke professionally, his authority superseding even that of the king where the two conflicted. It was natural enough that the statesman on the throne should dislike, and vehemently dislike, this sort of *imperium in imperio*. So long as king and prophet agreed, which they seldom did, upon the course of government, all went smoothly, and the spiritual power came in with might to the aid of the temporal; but whenever there was a conflict, it was war to the knife. Unfortunately for the people, they were seldom on the prophet's side, inclining more frequently to take the part of the prince of this world—who, so long as they paid taxes and gave recruits for the army, allowed them to do pretty much as they pleased—rather than the part of the servant of Jehovah, who, for all that He had brought them out of Egypt, and blessed them in many things beside, was too highly exalted out of their reach for them to have sympathy with Him, and who was also of purer eyes than to behold iniquity. Instances of conflicts of this sort are many and flagrant in the course of the Old Testament Scriptures, from which it will also be seen that it was a natural tendency in the people to "start aside like a broken bow" whenever the yoke of the Divine King was laid upon them for their good. It was in consequence of this tendency that a temporal king became necessary.

"GOD SAVE THE KING."

Let us, before considering the constitution of the kingdom of Israel, sketch briefly the principal features of Jewish history up to the time when a king was demanded. Certain Arabs, known to us in Biblical writings as the sons of Jacob, fed their flocks and herds in the country near to Shechem, and led the nomadic life of shepherds in a land barely fruitful enough to support them. This difficulty naturally increased with the increase of population, and at times the chiefs were straitened

to know what to do for food. These chiefs were non-elective heads of families, exercising despotic power over children and children's children, their authority being checked only by fear of physical resistance in their subjects. They were what Tartar or Arab chiefs are in the present day—patriarchal rulers, governing not according to any fixed law, but giving judgment according to discretion upon each case as it arose.

It so happened that about the year B.C. 1706 a drought of unusual severity forced these Arabs to look beyond their own immediate compounds for sustenance for themselves and their little ones. Many of the cattle and sheep died, and it was becoming a question of human lives also. To the neighbouring land of Egypt the eyes of the Arabs were turned; the dread of famine overcame their repugnance to mix with people alien to themselves, and some of the great chief's sons were sent down by their father to buy the necessary supplies in the fruitful land of Egypt. Egypt was the market in which they had been accustomed to sell the surplus of their own stocks. It was already known to them commercially and by repute as one of the most flourishing and richest countries in the world. Periodically it had been their practice to send down thither, and we have mention made in the Bible of some of these visits. Generally, however, they did their business through agents—merchants who came up expressly from Egypt to deal with the wanderers, and returned with their purchases in a caravan. To such dealers, a short while before the famine alluded to, the sons of Jacob sold their younger brother Joseph, against whom they bore jealousy; and from such dealers they would gladly have bought all the supplies of food they needed. But the famine was so sore in the land that the merchants would not come up into it, and those who sought produce from Egypt were therefore compelled to go down into that land and seek it there. The sons of Jacob went down, under the circumstances so familiar to readers of the Old Testament history, and found "corn in Egypt." This was sold to them by the governor of the province, who proved to be their own brother, and whose excellent behaviour and able administration had won for him the rulership over many cities, and the right of entry into the joy of his lord.

Political circumstances, which were stated at length in the Historic Sketch of Ancient Egypt (page 206), induced the Pharaoh who at that time reigned over Egypt to invite the Israelites to settle in that country. He knew what Joseph had done towards reorganising the kingdom, and he doubtless thought that a whole nation of such men would be a splendid leaven to mix with the elements of his own state. Besides, the Israelites were children of the desert, accustomed to rough it, and likely to shame the Egyptians out of some of the effeminacy into which they had fallen. They would also, established on the confines of the kingdom desertwards, act as a shield between the Egyptians and those marauding dwellers in the desert who afterwards overthrew the native rule in Egypt. Thus we find that, by the space of about 215 years, the Israelites, invited by the Pharaoh who was Joseph's friend, abode in the land of Egypt, and suffered all and more than the tyranny imposed upon the Egyptians by those Hyksos, or shepherd-kings, who looked upon the Israelites as traitors to the original nomadic mode of life. The history of their adversity is more familiar to us than that of their prosperity, and we know comparatively little of what they did, or of what influence they exercised in the land of their adoption. Probably their influence was less beneficial than the Pharaoh, who judged of them by what Joseph was, hoped it would be. They were, in more senses than one, "a peculiar people," living distinct from the rest of mankind, not likely to weld themselves in with the mass of the people, and not calculated, therefore, to perform the part of the leaven which Pharaoh had hoped for. But they were treated with a wise liberality and a uniform kindness till there arose a Pharaoh "that knew not Joseph," till the shepherd-kings had come in from the desert and mingled Egyptian and Israelite in a common ruin. The story of their wrongs, and of the marvellous circumstances under which they were delivered from the most galling bondage, is written in the books of Moses. There, too, will be found the history of their wanderings for forty years in the wilderness. Moses, committed to positive action on behalf of his people by the homicide of the Egyptian whom he slew for insulting a Hebrew, was the man under whose guidance the Israelites were brought out of the land with a mighty hand and a stretched-out arm. The difficulties he encountered in getting permission to go, the miracles that had to be wrought—the last with so much dreadful destruction to life—before the permission was accorded, the pursuit by the King of Egypt, the overthrow of his army in the Red Sea, the entry of the Israelites into the desert beyond, and their history during the forty years before they entered the promised land, we know from the hand of Moses himself, or of one who was his companion and amanuensis. By the light of that history it is not difficult to see that the Israelites were just exactly the people *not* to be contented with the theocratic government which Moses established over them. Though educated enough to comprehend the folly of idol

worship, and to know that disunion in the state meant political weakness, they, nevertheless, under circumstances which made it extreme sin in them, again and again committed idolatry, and conspired also to overturn the authority of him under whose leadership alone they were safe. In the same spirit as that of the insulting inquiry, "Who made thee a ruler over us?" the Israelites conspired against the authority of Moses, who, rigorous as he necessarily was, in the presence of facts that rendered it imperative there should be "a dictator whom all men should obey," exercised his authority with a wonderful amount of self-denial, and with a constant feeling of intense responsibility to the visible majesty of Jehovah, who was the Lord and King of the people. If we sometimes pause as we read the narrative of Moses' acts, and note that in some cases the punishment meted out by him to rebels appears to be in excess of the offence, we should remember that under circumstances like those which surrounded him cruelty is often merciful, and that he resented not any injury to himself, though he was insulted, maligned, and provoked every day of his life, but high treason to Him whose steward and servant he was. When he himself, or when Aaron was in question, he could afford to let the slanderer speak, to brook the insulting word and gesture, and to pass by in contempt the murmurings of the discontented. But when the words and deeds of rebellion were directed towards the Almighty, the zeal of God's servant knew no bounds; he called down the lightning from heaven upon the offenders, and bade the earth open and swallow them up; the quality of mercy was dried up in him; he invoked God's "wrath, anger, and displeasure" upon the people, and prayed of Him to send evil angels among them. Only when the people were humbled and cowed would he intercede for them, only when they had been persuaded by the terrors of the Lord would he consent to ask God to hold His hand.

A government like that of Moses was new to the people. They had seen priestly government, or rather the priestly ascendency in the government, in Egypt, but there the jealousy of statesmen and the need for secular aids had prevented the complete domination of the priesthood. But a pure priesthood, reflecting the image of the heavenly King, was more than they could tolerate, if not more than they could understand. They could not bear the light which as a pillar of fire accompanied them, they resented the prying gaze of an eye which was unable to look on iniquity. Moses was the human representative of that light, of that eye; the incarnate expression of that Lawgiver whose laws it was so impossible for poor human nature to obey; and therefore the rebellions against him and his authority were not many only but desperate, exhibiting a complete *abandon* of all the higher and better instincts, such as might be naturally expected of those who felt they could not attain to the brilliancy of the light at the same time that they could not escape from it. The Jews seem to have been utterly unaware of the representative part they were destined to play in the history of the world, and to have looked only to present ease or advantage in framing their rules of conduct. They walked by sight and not at all by faith, and they stumbled at every turn.

For a while the Jews bore with the theocracy, especially when, as under Joshua, it was associated with the warrior element in their leader; for a term, after their advent into the promised land, they consented to remain under the guidance of judges, who were the avowed lieutenants of the heavenly King Himself, the self-denying "servants of the servants of God." But the temptations to which the people subjected themselves, and before which they fell; were too strong to be counteracted by the severe law of unswerving right; the sins and follies of the people infected the judicial office also, till at length it became questionable whether aught was gained, whether something was not rather lost, by the continuance of the régime which had been tried and found wanting. The scandal presented by some bearers of the judicial office, both as regards their life and doctrine, was such that no good, humanly speaking, could possibly accrue from the continuance of the office; experience had proved that the pure priestly government, even the visible presence of God between the cherubim, would not suffice to keep the people in the straight but narrow path; it was better, therefore, to withdraw the presence which overbore the people, and which could not adequately be represented by ordinary men, and to substitute for it a system of government, lower in kind and degree, which yet might be under guidance and confess the Lord Jehovah as supreme. Thus it happened that Saul was made king over Israel, and thus it happened that Samuel, preserving the character but not the local power of his predecessors, exercised a sort of irresponsible control over him, even announcing to him at the end how the Lord repented He had made him king. Successors of Samuel there were in the long line of illustrious prophets, of some of whom mention is made so frequently in the Old Testament, men who fully accepted the new position which spiritual influences were to occupy in relation to man, who ceased to terrify by governmental acts, and looked to uncarnal weapons as best befitting the servants of Him, who not being of the world was yet to come into it.

Successors they had and ever have had, both before and after the advent of the Redeemer whose witnesses they were, and who came to restore once again in His own person the functions of the priest and king. To preserve pure and undefiled the word of God to man, to warn, to exhort, to threaten, as fathers caring for their own children—this became the function of the prophets as representatives of the Lord Almighty. The duty of the kings whom God gave the people was to lead them by means which they could understand to that goal to which prophets and judges, acting directly, had pointed in vain, and to show them, by precept and example, the sort of life which the chosen people should lead to entitle them to the actual sovereignty of the Messiah.

When a king was first given to Israel it was clearly understood that he should be under the tutelage of prophets, who should communicate to him the will of the King of kings, in whose name and in whose stead he wore the crown. This tutelage was exercised by the prophets in a way that was not likely to be acceptable to princes, especially to princes who preferred to reign in their own names to the name of the ultimate King of Israel; and we find early instances of dire conflict between the spiritual and temporal powers—conflicts which went to the extent of deposition on the one side, and of sanguinary persecution on the other.

For a time, however, Saul was king, in spite of the murmurs of those who objected to the elevation of an equal; and in his successful wars with the Philistines and the Amalekites justified the choice which had appointed him king. His valour and personal prowess, seconded by the gallant efforts of his sons, especially of Jonathan, won for him a renown which no amount of subsequent misfortune could extinguish. Even in the wrong he did by not obeying the express commands of the prophet who had anointed him king, he was credited with an amount of generosity that went far in the people's sight to excuse him, while as a leader and prince he enlisted their entire sympathies. The disobedience of which Saul was guilty in the matter of Agag was but one of many instances in which, while he showed himself a man of whom an army of Philistines might have been proud, he showed incontestably that he was not fit for the post of vice-gerent for Jehovah. For these acts of unfaithfulness Saul was deposed, although he was allowed to die the death of a warrior instead of falling into the hands of his enemies, and the kingdom was given to another. Judged by any other than the highest standard, Saul would have been considered guilty of at least venial offences in what he had done, and there was a certain something about him, which, in spite of his brutality, made him admired of his subjects—a soldierly feeling which has been portrayed in the well-known Hebrew melodies of Lord Byron—

> "Warriors and chiefs, should the shaft or the sword
> Pierce me while leading the hosts of the Lord,
> Heed not the corse, though a king's, in your path;
> Bury your steel in the bosoms of Gath."

The kingship which was taken from Saul was conferred upon David, of the tribe of Judah, in spite of an opposition manifested by the northern tribes in favour of Ishbosheth, a younger son of Saul. The splendour of David's reign, his success in war, and the faithfulness with which he accomplished his mission to destroy the heathen who hemmed in the chosen people, and set them examples which they were too prone to follow, are matters well known to all who are familiar with the Bible narrative. During the reigns of David and of Solomon the feeling of dissension between the northern and southern tribes which had shown itself at Saul's election, and again at his death, did not express itself in any national way. The rebellions against David were encouraged and fed by it, and the fact of its existence was vouched for in several independent ways, but not nationally. On the death of Solomon, however, this dissension took an active form. The expenses of Solomon's government had pressed sore on the people, who complained that the wealth of the nation was centred in one city, that the general welfare was neglected for the sake of Jerusalem, and that the king cared little what happened to other borders of his kingdom so long as the borders of Judah and Benjamin were respected. This feeling was so far from being wisely dealt with by Rehoboam, Solomon's son and successor, that he openly declared his intention of governing yet more severely than his father had done, of chastising with scorpions instead of whips, and of holding himself accountable to no one, but to his own will only. In vain did Jeroboam, as representative of the northern tribes, request redress of grievances; the king refused to believe in the extent of the disaffection towards him, and dismissed the remonstrants at the same time that he sent out collectors to gather in his taxes. The tax-gatherer in this as in other cases proved to be the solvent for loyalty; the ten tribes in the north of Palestine revolted from the house of David, asking, "What part have we in Jesse?" and crying, "To your tents, O Israel." From this moment began not only a disunion, but a hostility, that proved the death-wound of the Israelitish power. A king reigned in Jerusalem over the tribes of Judah and Benjamin, and was

called the King of Judah, while "the son of Nebat" made Israel to sin in the country north of Judah, and established in all the high places an idolatrous worship of the gods of the surrounding heathen nations. He was called the King of Israel.

Between the two kingdoms the most bitter rivalry prevailed—a rivalry which was perpetuated down to the time of our Lord Himself, when it might have been thought that the common subjection to a common enemy—the Roman—would have wiped out the enmity anciently existing between them. This enmity showed itself in wars, in secret machinations of each against the other's interest, and in a dissension which ultimately proved the downfall of both the divided kingdoms. Instead of combining, as a chosen people should have done, against the assault of foes not only to themselves, but to the God who was their ancient Lord, they strove which should be the greater, and alike disregarded the warning voices which that God sent from time to time to admonish them of the evil of their ways. Israel from the first seemed to think that revolt from the King of Judah involved also revolt from the God of Judah, and accordingly instituted a worship of images and of the god Baal, which form the object of so many denunciations in the prophetical writings. A continuous line of princes who defied as it were the God of their fathers, and a line hardly so continuous, of prophets who testified to the wrath of God against the children of disobedience—this is the sight presented to the student of Israelitish history during many decades of years. Intrigue, rebellion, murder—these were the concomitants of the royalty of Israel, and the outcome of the religion which the people picked up from the surrounding nations.

Under Jeroboam Israel was made to sin, and under his successors continued to do so, now more, now less; now excelling in wickedness as under Ahab and Jezebel, and Jehoram; now appearing to strive for a while, as under Jehu, to enter in at the strait gate. The faithfulness of Elijah and of Elisha in testifying to the God of Israel was exhibited in vain before them; in vain were wonderful miracles wrought by Elisha in their sight; in vain were the national enemies driven back from the land by the direct interposition of the Almighty. Given over to "do evil in the sight of the Lord," king and people no more regarded the law of their God than their forefathers had done when the Divine presence was daily with them. They early forsook the temple of Jerusalem, and so severed the one common link that bound them to Judah. On Mount Gerizim they built a rival temple to that of Solomon, and used it as occasion served for the honour of Jehovah or Moloch. Occasionally, but rarely, there was peace between Israel and Judah. Alliances were broken as soon as made, by the spirit of jealousy which animated either people, and by the want of real community of interest. Sometimes the two states combined to resist the encroachments of an Assyrian king or a Ninevite ruler, and learnt in adversity to remember Him who had wrought such wonderful things in their behalf. But secret disagreement, if not open hostility, was the chronic relation between the brother kingdoms; and when the measure of Israel's sin was full, and Shalmaneser smote Israel with the sword and took away the people captives beyond the Euphrates, Judah stood aloof, and witnessed the overthrow of his brother with calmness if not with satisfaction. The children of Israel were scattered abroad, Assyrian colonists were thrust into their pleasant places, and the throne of Samaria was held as tributary to that of Assyria by a lieutenant of the foreign king. In the year B.C. 719 the kingdom of Israel was thus destroyed, and was never reconstructed.

The kingdom of Judah survived, a small but compact state—a sort of Belgium—owing its existence, humanly speaking, to the jealousy of the great kings of surrounding nations, who could not annex it without exciting wars which for many reasons they could not afford. At the same time its advantageous geographical position, its good seaboard, and its great natural strength, made it a most desirable place to have and to hold. It was clear that its annexation must come sooner or later, being dependent only upon the balance of power abroad being destroyed by the overthrow of one of the great empires and the domination of another. Judah was to learn, as Israel had learnt, that it is not in princes that trust must be placed; was yet to learn—has yet to learn—that until she can choose as her king, not Saul, not David, not Solomon, nor another, but Him whose royal authority she renounced these many centuries ago, there is no rest for the soles of her feet, no slumber for the temples of her head. As a purely secular state, having kings like other nations, she was weak in spite of the culture of her people, a standing temptation to the great princes of the East to swallow her up. The history of her wars, of her domestic troubles, of her subjection, recovery of independence, and final deletion as a power, is a history full of general interest, and in some parts full of pity; but it is the history of a people with whom the student can feel little particular sympathy, of a people who seem to have provoked so thoroughly the wrath that came upon them as almost to make one approve the acts of enemies in themselves reprehensible.

Egypt, Babylon, Syria—these were the states against which Judah had at various times to contend. The Edomites, Philistines, and Ammonites were lesser foes, let loose upon her from time to time, with the intention apparently of bringing her back to her allegiance through the medium of sorrow. Heedless of the warnings given to her, thankless for help lent, she was allowed to accomplish the sum of her transgressions by crucifying the King to whom she had looked forward for redemption. The Prince whose coming had been foretold with increasing distinctness by prophet after prophet, the assurance of whose coming had been the comfort of the people when by the waters of Babylon they sat down and wept, was betrayed by His friends and put to death by His subjects, who could not recognise Him through the mists which centuries of disobedience and unfaithfulness had cast before their eyes. Scattered throughout the world, no more a nation though a people, the Jews still hesitate to ask for the King who shall reign over them. When the Jews are assured that the kings they have had, from Saul to Cæsar, were no kings, and acknowledge the wrong their fathers did in renouncing the King of kings, looking on their punishment through these long ages as a just retribution, they will be restored to their own land. Later on, it is to be hoped, in God's own time, they will recognise the means by which the days were shortened so as to allow of the remnant, which they represent, being saved. As it is, they sing the Lord's song in a strange land.

See:—*Cassell's Universal History*; Geikie, *The Holy Land and the Bible*.

COMMERCIAL BOTANY OF THE NINETEENTH CENTURY.—XI.

[*Continued from p.* 214.]

FIBRES.

Few branches of manufacture have attracted so much attention in recent years as the application of new fibres. The numerous uses to which fibres are put will sufficiently explain this; paramount, of course, must always be that for textile purposes, then for rope and cordage, next as a substitute for bristles in broom and brush-making, and finally for paper-making, which has been treated of under a distinct heading.

It is, then, for the first three uses that we have now to consider the fibre supply, and in glancing at the subject from its first aspect, mainly as furnishing textiles, we may briefly allude to the cotton supply, which, in 1800, was only about 600,000 cwt., the increase going on steadily down to our own time, as will be seen from the following statistics:—

1837	Total imports of	raw	Cotton	3,636,489	cwt.
1856	,,	,,	,,	9,141,842	,,
1860	,,	,,	,,	12,419,096	,,
1862	,,	,,	,,	4,678,333	,,
1866	,,	,,	,,	12,295,803	,,
1886	,,	,,	,,	15,187,299	,,
1887	,,	,,	,,	15,903,117	,,
1897	,,	,,	,,	15,394,234	,,

It will be remembered how seriously the American civil war affected the cotton trade in this country, and this is specially marked in the above table. Much larger supplies were at that time drawn from British India, and of the total imports for the year 1897 British India exported 129,700,000 rupees worth.

In 1876 a new kind of cotton was introduced to the notice of planters under the name of Bamia Cotton. It made its first appearance in Egypt, and attracted a good deal of attention on account of its mode of growth and its abundant fruit-bearing. It was described as sending off branches regularly from the bottom of the main stems upwards, but bearing close to the ground two, three, or more branches, and then rising to a height of eight or ten feet without a branch. This erect growth was considered an advantage, inasmuch as a much larger number of plants could be grown within a given area than is possible with ordinary cotton. The plant was also described as a prolific fruit-bearer, so that the yield was estimated at a considerably higher rate than any other known variety. In consequence of these very strong recommendations the seeds were distributed as widely as possible from Kew, with very varied results. The quality of the cotton was reported as not to be materially different from that of ordinary Egyptian cotton, of which, indeed, it was found to be a fastigiate variety. Bamia cotton is now seldom or never heard of.

A textile fibre of undoubted quality (Rhea or Ramie) is the so-called China Grass. This fibre seems to have made its first appearance in this country in the form of finely woven handkerchiefs not long before 1849, for it was about this time that a specimen of the fabric was received at Kew together with other materials, from which it was found that the plant furnishing it, though called China Grass, was in reality a bushy-growing nettle—the *Bœhmeria nivea* or *Urtica nivea* of botanists. From this time the fibre began to attract much attention, and a patent was obtained in the same year (1849) in connection with its preparation. At the Great Exhibition in 1851 three prize medals were awarded for China Grass fibre.

It was then proved that from the fibre, properly cleaned and prepared, fabrics could be woven equal in every respect to the finest French cambric. Notwithstanding this, the interest in China Grass dwindled down and remained in abeyance for some time, till in 1865 a fresh interest was given to it by the American Vice-Consul at Bradford, Yorkshire, suggesting to his Government at Washington the desirability of their introducing the plant and fostering its growth in the United States, for the double purpose of utilising its fibre in America and of exporting it to this country. The practical results of this communication, though it excited fresh interest in this country at the time, were almost *nil*. The great desideratum was the invention of a machine that would clean the fibre and prepare it at such a cost that it might be put into the market at a price to compete with other textiles of a similar character; and with the hope of attaining this end, the Indian Government offered in 1869 prizes of £5,000 and £2,000 for such a machine. A Mr. Greig was the only competitor, and his machine did not altogether fulfil the conditions necessary for complete success, so that the matter again dropped. In the meantime the China Grass plant has been grown for experimental purposes in the south of France, near Marseilles, and in Algeria, and many new inventions in machinery for its preparation have been made in England, America, and on the Continent. During the year 1887 a fresh impulse was given to the fibre by a series of experiments with new machinery in Paris, as well as by the adaptation of a flax-cleaning machine, invented by Mr. Wallace, and exhibited during the year at an Exhibition of Irish Industries held in London. At a still later period, namely, in the *Kew Bulletin* for December, 1888, it is stated "that those who have in a measure been successful in preparing the fibre in commercial quantities are disappointed at the reception it has received at the hands of the spinners and manufacturers."

The extended cultivation of the plant presents no difficulties; given a suitable soil and a locality having the necessary climatic conditions of heat and moisture, there is no doubt that the Ramie or China Grass plant could be cultivated in most of our tropical possessions. Regarding the question of the decortication of the stems, this problem remains still unsolved. And on this, as the *Kew Bulletin* says, "really hangs the whole subject. The third stage [that of spinning] is disappointing and unsatisfactory because the second stage [that of decortication] is still uncertain, and being thus uncertain, the fibre is necessarily produced in small and irregular quantities, and only comes into the market by fits and starts. It would appear that Ramie fibre differs so essentially from cotton and flax that it can only be manipulated and worked into fabrics by means of machinery specially constructed to deal with it. Owing to the comparatively limited supply of Ramie fibre hitherto in the market no large firm of manufacturers have thought it worth while to alter the present or put up new machinery to work up Ramie fibre. If appliances, or processes for decorticating Ramie in the colonies were already devised, and the fibre came into the market regularly and in large quantities—say hundreds of tons at a time—there is no doubt manufacturers would be fully prepared to deal with it. At present the industry is practically blocked by the absence of any really successful means of separating the fibre from the stems and preparing it cheaply and effectively. This, after all, is the identical problem which has baffled solution for the last fifty years."

Further trials in cleaning Ramie fibre by machinery were made in Paris during the Exhibition of 1889, the results of which have been recorded in the November and December numbers of the *Kew Bulletin* for that year. It will suffice for our purpose to know that the conclusions arrived at were that France appeared to be the best market for the fibre. A well-known London firm of fibre brokers reporting on the trade in November, 1889, say that strips of the bark known as ribbons were sold during that week at from £14 to £16 per ton, and that they were disposed to think that the bases of a real trade in the article were in process of formation.

Since the above was written a considerable advance has been made in the development of these valuable fibres, and it has been shown that China Grass is the produce of *Bœhmeria nivea*, and Ramie or Rhea that of *B. tenacissima*.

About the year 1860 a substance called PINE WOOL was introduced to notice, two factories having been established near Breslau, in Silesia; the process consisted of reducing the pine leaves to a coarse kind of fibre of a brownish yellow colour. This was used for stuffing cushions, mattresses, etc., and as a kind of wadding; more recently it has been made into a yarn and woven with animal wool and sold as pine wool flannel, which is said to have advantages over ordinary flannel, inasmuch as it keeps the body warm without heating, and is very durable. Much of the Pine wool flannel that is in the market consists partly of animal and partly of Pine wool. The pine chiefly employed is *Pinus Laricio*. Within the last ten or twelve years, Pine wool has been made in North America from the long leaves of the Turpentine Pine (*Pinus australis*).

Perhaps no other fibre, whether textile or otherwise, has made such rapid strides as a commercial commodity as JUTE. The beginning of the jute trade is intimately associated with Dundee, and dates back about fifty years. It is the inner bark of two or more species of *Corchorus*, of which *Corchorus capsularis* and *C. olitorius* are the chief. They are annual plants belonging to the natural order Tiliaceæ, and are now largely cultivated in India, especially in Bengal, exclusively for the sake of this fibrous bark. This bark was at one time used only to make Gunny bags in which to export Indian raw sugar; these, after being emptied of their contents in this country, were sold to the Jews, who, after extracting the remaining sugar by boiling, sold the old bags to the paper-makers to be converted into pulp or paper stock. The fine glossy character of the jute fibre soon, however, began to recommend itself for textile purposes, and in 1846 9,300 tons were imported into this country, which rose in 1887 to 373,480 tons, and in 1897, 336,919 tons.

At first jute was used only for mixing with wools in cheap druggets and carpets. At the present time it is applied to a great variety of purposes, such as imitation tapestry, carpets, cords, twines, and even for mixing with cheap silks, to which it lends itself on account of its bright glossy appearance.

MANILA HEMP has long been known as a strong and valuable fibre for rope and cordage making. It is obtained from the stems of *Musa textilis*, a native of the Philippines. Hitherto Manila hemp plants have not thriven on a large scale outside the Philippine Islands. The character of the Manila hemp plants grown at Kew, and distributed to the West Indies and tropical Africa, gave hopes that it might be possible to obtain plants with a more robust habit and capable of yielding a larger quantity of fibre. An application was made with this view to H.M. Consul at Manila, who was good enough to obtain and forward to Kew a case containing 47 suckers. These arrived in November, 1894. They yielded a number of strong, healthy plants, which so far promise to do much better under cultivation than the previous plants.

Amongst vegetable fibres used for brush- and broom-making several very important introductions have been made, foremost of which, of course, is the fibrous husk of the Cocoa-nut (*Cocos nucifera*). This fibre, now so generally known by the name of COIR, has become within the last thirty or forty years a most important article of import. Its introduction may be said to date from about the year 1836, when a shop for the sale of articles made of coir was opened in Agar Street, Strand. In 1839 a partner in this business took out a patent for the manufacture of various fabrics from the fibre, and from that time its uses rapidly increased.

In the process of separating the fibre from the cocoa-nut husk three distinct commercial articles are produced, namely, the long fibres used for matting and mats, the shorter or more stubborn fibres for brooms and brushes, and the still shorter or refuse for horticultural purposes.

Another important brush-making material, but of more recent introduction, is BASS or PIASSABA, the produce of two distinct palms, namely, *Leopoldinia Piassaba* from Para, and *Attalea funifera* from Bahia. These two kinds are distinguished in trade, the fibre of the *Attalea* being superior to that of *Leopoldinia* for brush-making on account of its being stiff and yet "springy," so that longer lengths can be used; the Para fibre is more flexible, and can only be used in short lengths—it is, however, of a brighter colour. The *Attalea* fibre can be obtained either very fine or very thick and strong; each fibre is more or less round, while the Para kind is flat.

The introduction of Piassaba fibre into England for brush-making dates back about fifty years, and is almost, if not entirely, due to the exertions of Mr. Arthur Robottom. In 1861 nearly 6,000 tons of Piassaba were imported into England.

About the year 1880 a new kind of Piassaba was introduced to the British market from Madasgascar, and still forms an article of import. The fibres are thinner and much softer than those of either the Para or Bahia kind, and, consequently, not so valuable for brush-making.

This has since been described as the product of a new species of palm under the name *Dictyosperma fibrosum*, and is referred to in the *Kew Bulletin* for 1894, p. 359.

In 1890 a thick, wiry fibre was introduced as LAGOS or AFRICAN BASS. It soon proved to be obtained from the petrole, or leaf stalk, of the Wine Palm (*Raphia vinifera*). When first introduced it was valued in London at £25 per ton, and a few bales of very carefully prepared fibre actually realised £42 per ton. Its present price in the London market averages £10 to £30 per ton. Its history is fully reported in the *Kew Bulletin* for 1891, p. 1, and 1892, p. 299.

In 1892 yet another bass fibre was introduced, this time from Ceylon, consisting of the woody fibres from the leaf stalks of the well-known Palmyra Palm of India. This was sold at the time for £28 per ton; its present quotations being from £25 to £35, according to quality. Some interesting notes on this substance will be found in the *Kew Bulletin* for 1892, p. 148.

Later on another fibre took a prominent position in the brush trade under the name of KITTOOL, which is found in large quantities around the bases of the leaves of *Caryota urens*, a well-known Cingalese palm. Kittool fibre has been known in this country for some thirty or forty years, but it is within the last six or eight years that it has become a regular commercial article. When first imported the finer fibres were used for mixing with horsehair for stuffing cushions. As the fibre is imported it is of a dusky brown colour, but after it arrives here it is cleaned, combed, and arranged in long straight fibres, after which it is steeped in linseed oil to make it more pliable, this also has the effect of darkening it, and it becomes indeed almost black. It is softer and more pliable than Piassaba, and can consequently be used either alone or mixed with bristles in making soft long-handle brooms, which are extremely durable and can be sold at about a third the price of ordinary hair brooms. The use of Kittool fibre is said to be spreading not only in this country but also on the Continent.

THE JUTE PLANT.

1, Specimen of Corchorus olitorius; 2, Upper part of the same in flower (one-third natural size, flowers yellow); 3, Single flower (natural size); 4, Ripe fruit (natural size).

Under the name of MEXICAN FIBRE or ISTLE a stiff fibre is now imported into the English market chiefly for making scrubbing and nail brushes. The history of this fibre is interesting, and may be given briefly, as follows:—When the war broke out between England and Russia one of the sources of hemp, namely, from Russia, was stopped; the Istle, which was known to some Mexican merchants, was suggested as a substitute, and a small trial shipment was made to England. It was soon found, however, that it was unsuited for rope-making. A portion of it having come into the hands of Mr. Robottom, whose name has before been mentioned in connection with Piassaba, he at once suggested its use for brush-making, and purchased the whole consignment of about twenty tons that had been shipped from New York to Hamburg. On arrival in this country it was sold for about £28 per ton; the price soon rose to £85 per ton, falling to £18, and afterwards rising again at the time of the insurrection in Mexico to £140 per ton. The trade afterwards increased very rapidly, and the fibre is now imported in very large quantities, chiefly from Tampico, and used for making scrubbing and nail brushes, whitewash brushes, bath brushes, etc., and at one time it was largely used by crinoline-makers. The source of this fibre was unknown till in 1879 Dr. Parry sent specimens to the Kew museum under the name of *Agave Lechuguilla*. This, however, has some time ago (*Bulletin of Miscellaneous Information, Royal Gardens, Kew, No. 12, December*, 1887, p. 5) been shown to be identical with *Agave heteracantha*, to which plant Mexican fibre or Istle must now be referred. The value of this fibre is stated to be about £26 per ton.

Another Mexican brush fibre, the botanical source of which has also some time since been cleared up, is known as BROOM ROOT or MEXICAN WHISK. Though it appears to be a comparatively new industry, there seems to be no record when it was first introduced. It is shipped from Vera Cruz, chiefly to Germany and France, a small quantity only coming direct to this country. In France, however, it is mixed with Venetian Whisk, the roots of *Chrysopogon Gryllus*, which, though somewhat lighter in colour, are similar in appearance but of a superior quality, and in this mixed condition it is exported to England for making clothes, velvet, carpet, and dandy brushes. The roots are known in Mexico as "Raiz de Zacaton" and are referred in the *Bulletin of Miscellaneous Information, Royal Gardens, Kew, No. 12, December*, 1887, p. 9, to *Epicampes macroura*.

About twenty years ago a new material was introduced for gardening purposes, namely, for tying plants, under the name of ROFFIA or RAFFIA; for some time the origin of this article remained unknown, but it was subsequently proved to be the

thin but very strong cuticle of the leaf of *Raphia Ruffia*, a palm, native of Madagascar. It is exported chiefly to Mauritius and thence to England, at the present time in very large quantities. Its value in the London market ranges from £25 to £200 per ton, but its average price may be taken at from £40 to £50 per ton.

In Madagascar this same substance, split into fine threads and dyed, is used for making mats and cloths, some of which are very beautiful.

It is said that the cuticle of the leaves of *R. tædigera*, a Brazilian species, is also exported to this country and helps to make up the bulk of the Roffia of trade. This material has entirely supplanted the old Cuba Bast, from *Hibiscus elatus*, which was so largely used in gardens about forty years ago. It was originally used for tying up bundles of real Havana cigars, but during the Russian war, when the bast from the Lime tree became scarce, it was used as a substitute, and has now passed from notice to give place to Roffia.

In the London International Exhibition of 1862, amongst the South African products some prominence was given to a stiff black fibre, which was advocated for brush-making, as a substitute for horsehair, and for paper-making. This fibrous substance was known as PALMITE or PALMIET, and is found in quantities encircling the stems of *Prionium Palmita*, a stout-growing plant of South Africa, belonging to the natural order *Juncaceæ*. Though it attracted some attention at the time, it never came into actual use.

ELECTRICITY.—II.

[*Continued from p.* 205.]

SPECIFIC RESISTANCE—RESISTANCE OF CONDUCTORS—VARIATION OF RESISTANCE WITH TEMPERATURE—RESISTANCE COILS AND BOXES.

It has been stated that different materials offer widely different resistances to the passage of a current through them; in other words, each material offers a resistance peculiar to itself, and known as the **specific resistance** of the material. *The specific resistance of a substance is the resistance in microhms at 0° Cent., of a piece of that substance whose length is one centimetre, and whose section is one square centimetre.* The specific resistance is also expressed in inches, and is given in the following table. (A microhm is the one-millionth part of an ohm. The prefix "micro" always signifies the millionth part of the word to which it is prefixed; thus, a microvolt is the millionth part of a volt, a microfarad is the millionth part of a farad, etc.)

The following table contains the specific resistances per cubic centimetre, and per cubic inch, of some of the metals commonly used in electrical work:—

TABLE OF SPECIFIC RESISTANCES OF PURE METALS.

Substance.	Resistance in microhms, at 0° Cent.	
	Per cubic centimetre.	Per cubic inch.
Silver, (hard drawn) - - - - - -	1·631	·6133
Copper " " - - - - - -	1·634	·6433
Zinc, pressed - - - - - - -	5·626	2·215
Platinum, annealed - - - - - -	9·057	3·565
Iron, " - - - - - -	9·716	3·825
Tin, pressed - - - - - - - -	13·21	5·202
Lead " - - - - - - - -	19·63	7·728
German silver - - - - - - - -	20·93	8·240
Platinum silver (an alloy of 1 of platinum to 2 of silver by weight)	24·39	9·603
Platinoid - - - - - - - - - -	34·00	13·40
Mercury - - - - - - - - - -	94·32	37·15
Manganin - - - - - - - - - -	44	17·3

The resistance of any body depends upon its geometrical construction; the longer the body is the greater is its resistance, and the thicker the body is the less is its resistance; the resistance is also proportional to the specific resistance of the body. These statements amount to the following:— **The resistance of any body varies directly as its length, directly as its specific resistance, and inversely as its sectional area.** Expressed in symbols, this most important law becomes

$$R = \frac{L}{A} S,$$

where R = the resistance of the body through which the current flows,
L = the length of the body through which the current flows,
A = the sectional area of the body through which the current flows,
S = the specific resistance of the body through which the current flows.

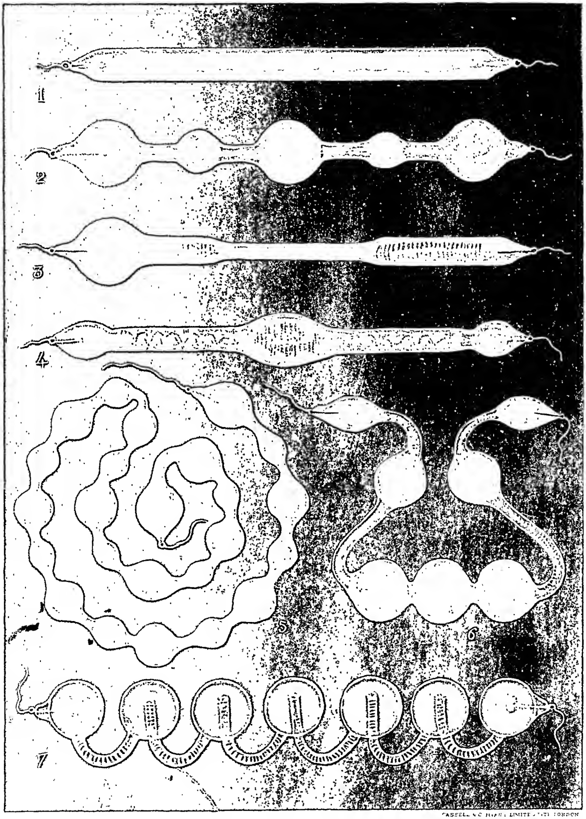
It must be carefully borne in mind that if L and A are expressed in inches, then S must also be expressed per cubic inch; and if L and A are given in centimetres, then S must be given per cubic centimetre. The answer, R, is always in microhms, but it may be brought to ohms by dividing by one million.

EXAMPLE 1.—What would be the resistance of a copper rod 800 yards long, and a quarter of a square inch in sectional area?

Here $L = 800 \times 3 \times 12$ inches,
$A = \frac{1}{4}$ of an inch,
$S = 0·6133$ microhms (*from the table*).

Substituting these values for the letters in the above formula, we get

$$R = \frac{800 \times 3 \times 12}{\frac{1}{4}} \times 0·6133$$
$$= 800 \times 3 \times 12 \times 0·6133 \times 4$$
$$= 74100 \text{ microhms},$$
or 0·0741 ohm. *Answer.*



ELECTRIC DISCHARGES IN RAREFIED GASES.

1, Vacuum Tube showing Fluorescence of Sulphuret of Calcium; 4, Vacuum Tube showing Nitrogen Vacuum (Spirals of Uranium Glass); 7, Vacuum Tube showing Hydrogen; 2, 3, 5, 6, Vacuum Tube showing Geissler Tubes.

In electrical work the conductors that we usually have to deal with are wires of circular section, and usually of small diameters; it is very seldom that we meet a wire having as much as a quarter of a square inch in sectional area. The inch has been found an inconveniently large unit for expressing the thickness of small wires, and hence a smaller unit—the *mil*—has been universally adopted in England. *One thousand mils make one inch.*

If we want to find the resistance of any wire we must measure its length and its diameter. We cannot measure its sectional area, but we can calculate it when we know the diameter of the wire. Thus,

$$A = \frac{\pi d^2}{4},$$

where d = the diameter of the wire in inches,
and $\pi = 3{\cdot}1416$.

For approximate calculations, the value of π may be taken as $\frac{22}{7}$.

EXAMPLE 2.—Find the resistance of an iron telegraph wire, 5 miles long and 165 mils in diameter. The first thing to be done here is to express the length of the wire in inches. Thus:

$$L = 5 \times 1760 \times 3 \times 12 \text{ inches.}$$

The next step is to calculate the sectional area of the wire in inches by the formula $A = \frac{\pi d^2}{4}$, remembering that d must be expressed in inches; thus,

$$A = \frac{3{\cdot}1416 \times \frac{165}{1000} \times \frac{165}{1000}}{4}$$

$$= \frac{3{\cdot}1416 \times 165 \times 165}{4 \times 1000 \times 1000},$$

and $S = 3{\cdot}825$ microhms (*from the table*).

Substituting these values for L, A, and S in the original formula, we get

$$R = \frac{5 \times 1760 \times 3 \times 12 \times 3{\cdot}825}{\frac{3{\cdot}1416 \times 165 \times 165}{4 \times 1000 \times 1000}}$$

$$= \frac{5 \times 1760 \times 3 \times 12 \times 3{\cdot}825 \times 4 \times 1000 \times 1000}{3{\cdot}1416 \times 165 \times 165}$$

$$= \frac{21{,}670{,}000{,}000}{380{\cdot}2}$$

$= 57{,}000{,}000$ microhms nearly.

or $= 57$ ohms. *Answer.*

The following is an example such as we may constantly expect to meet with in practice:—

EXAMPLE 3.—What current would a battery, having an E.M.F. of 14 volts and a resistance of 23 ohms, send through the above telegraph-wire, supposing that there is an instrument having 10 ohms resistance at each end of the line?

According to Ohm's law,

$$C = \frac{E}{R},$$

but $E = 14$ volts,
and R = the sum of all the resistances in circuit, which is the battery, the two instruments, and the line, or $23 + 10 + 10 + 57$ ohms.

Substituting these values, we get

$$C = \frac{14}{23 + 10 + 10 + 57}$$

$$= \frac{14}{100}$$

$= 0{\cdot}14$ of an ampere. *Answer.*

(The student is here strongly advised to work out a large number of examples similar to those given, in order to make himself thoroughly acquainted with Ohm's law, and the law connecting the resistance of a conductor with its geometrical form and its specific resistance.)

In the above examples it has always been taken for granted that the conductor with which we were dealing was entirely composed of the pure metal, but this ideal state of affairs is never met with in practice; the metal invariably contains some impurities, which have the effect of increasing its resistance; or, as it is more usually expressed, of lowering its conductivity. Copper is the metal most generally used in electrical work, on account of its low specific resistance, or, what is the same thing, *on account of its high conductivity.* Within the past few years the quality of the copper obtainable has immensely improved; and in specifications for any electrical work it is now usual to demand that the copper supplied shall have a conductivity of at least 98 per cent. of the pure metal. This means that the resistance of the copper supplied may be higher than that of pure copper in the ratio of 100 to 98. Returning to Example 1, let us find what would be the resistance of the rod if the copper had only a conductivity of 98 per cent.

The pure metal has a resistance of 0·0741 ohm, and this number must therefore be multiplied by the fraction $\frac{100}{98}$ in order to find the resistance of the rod when its conductivity is reduced to 98 per cent. Thus,

$$0{\cdot}0741 \times \frac{100}{98}$$

$= 0{\cdot}0756$ ohm (nearly). *Answer.*

A similar correction must always be made when the metal employed is not chemically pure; when we know its conductivity as compared with the pure metal the correction is quite simple, as is indicated; we merely multiply the calculated value by the fraction,

$$\frac{100}{\text{given conductivity}}.$$

VARIATION OF RESISTANCE WITH TEMPERATURE.

The effect which temperature has on the resistance of a body is very similar to that which it has on its volume. All the conducting bodies about which we have been speaking increase in volume when their temperature is raised, and all these bodies increase also in resistance when their temperature is raised. The non-conductors, or insulators, and the semi-conductors, do not follow the same rule; in fact, they behave in exactly the opposite manner—*their resistance decreases as their temperature is raised.*

All the metals that have been mentioned up to the present, and all the good conductors, increase in resistance on the application of heat, at a perfectly definite rate. Some metals increase in resistance more slowly than others; the alloys in particular, such as German silver, platinoid, etc., increase very slowly; in fact, each substance has a rate of increase which is peculiar to itself. A copper wire which has a resistance of 1 ohm at 0° Cent., has a resistance of 1·00388 ohm at 1° Cent., and a resistance of 1·00776 ohm at 2° Cent., and so on. The figure 0·00388 is peculiar to copper, and shows the rate at which that substance increases in resistance when heated through 1° Cent. The following table contains similar figures for the metals most commonly used in electrical work:—

TABLE SHOWING INCREASE OF RESISTANCE WITH INCREASE OF TEMPERATURE:—

Name of Metal.	Percentage of Increase per Degree Cent.
Silver	0·00377
Copper	0·00388
Zinc	0·00365
Tin	0·00365
Lead	0·00387
Mercury	0·00072
German silver	0·00044
Platinum silver	0·00031
Platinoid	0·00022
Manganin	0·00000 at 15°C.

Since the resistance of each substance changes with each variation of temperature, it is of the utmost importance that we shall know exactly what the resistance of the body is at any particular temperature. By means of the following formula we can always obtain the desired information:—

$$R_t = R_0 (1 + a t).$$

Where R_t = the resistance of the body which we want to find,

„ R_0 = the resistance of the body at 0° Cent.,

„ t = the temperature at which the body actually is,

Where a = the percentage of increase per degree Cent., as given in the above table.

EXAMPLE 4.—A German silver wire has a resistance of 200 ohms at 0° Cent., what resistance will it have at 20° Cent.?

Here $R_0 = 200$ ohms,
„ $a = 0·00044$ (*from the table*),
„ $t = 20.$

Substituting these values in the equation we get—

$$R_t = 200\ (1 + 20 \times 0·00044)$$
$$= 200 \times 1·0088$$
$$= 201·76 \text{ ohms. } \textit{Answer.}$$

Returning to the copper rod in Example 3, we have corrected for conductivity, but we must now correct for temperature. Let us suppose it to be at a temperature of 20° Cent., what will be its resistance at that temperature?

Its resistance, after being corrected for conductivity at 0° Cent., was found to be ·0756 ohm. Therefore we have

$R_0 = 0·0756$
$a = 0·00388$ (*from the table*),
$t = 20°$ Cent.

Substituting these values in the equation we get—

$$R_t = 0·0756\ (1 + 20 \times 0·00388)$$
$$= 0·0756 \times 1·0776$$
$$= 0·08155 \text{ ohm. } \textit{Answer.}$$

We have thus worked out completely the true resistance of a copper rod at 20° Cent., whose length is 800 yards, whose sectional area is a quarter of a square inch, and which has a conductivity of 98 per cent. of pure copper.

RESISTANCE COILS.

In order that we may be able to determine practically the resistance of any substance, it is necessary that we should possess a set of known resistances upon whose accuracy we can thoroughly rely. Such a set of resistances should, for convenience sake, be made up within the smallest possible compass; they should be made of such a substance as will not be liable to change with time, and whose resistance will vary as little as possible with variations of temperature; and they should be as inexpensive as is consistent with the above conditions. In order to do almost any kind of electrical testing, a good set of resistances is about the first requirement.

The substances of which accurate resistances are almost universally made are the metals, which are drawn into wires and then wound on bobbins fixed in a box, as will be presently described. The choice of a suitable metal is the first thing that has to be considered; and here the above Tables supply

all the necessary information. In the first Table it will be seen that for a given length and thickness silver and copper have the smallest resistances, and therefore, it would require a larger amount of these metals than of any of the others in order to make up a given resistance. These metals are also comparatively expensive, and from the second Table it is seen that their resistances vary considerably with variations of temperature. Every consideration thus points to the fact that these metals are not suitable for resistance coils; and still it is a curious fact that the old electricians—for reasons best known to themselves—usually made their resistance coils of copper. Besides the above disadvantages, a box of copper resistance coils would require more material, more labour, and would be far heavier and more unwieldy than is necessary.

Those metals which stand lowest on the two Tables are clearly the best for the construction of resistance coils—they have high specific resistances, and they vary very little with changes of temperature. The alloys German silver, platinum silver, and platinoid are specially suitable as the substances out of which to construct accurate and reliable resistance coils. Platinoid is a comparatively new alloy which undoubtedly will be extensively used for this purpose in the immediate future, though it has not been used to any great extent up to the present. Platinum silver is an admirable substance, but unfortunately it is very expensive; it is used for the construction of standard resistance coils, but its price forbids its use in ordinary commercial resistance boxes. German silver has a high specific resistance and a low temperature variation coefficient, it is inexpensive, and it does not change with time. These considerations have led to its universal use as the substance out of which to construct ordinary resistance coils.

The arrangement of the coils in a resistance box is shown in Fig. 1; the box itself—which is usually made of wood—is removed, showing its top, which consists of an ebonite slab, and the coils attached to it. This ebonite top is marked E E, and it has fixed on its upper surface a number of brass blocks; C^1, C^2, and C^3 are three of these blocks, each being firmly attached to the ebonite top by means of two substantial screws, which are driven up through the ebonite. The ends of the blocks are narrowed and undercut, as may be seen in Fig. 1; this device allows a larger insulating surface to separate the blocks, and allows that surface to be more easily cleaned by passing a rag or brush over it. The ebonite absorbs moisture from the atmosphere to a slight extent, and dust cannot be entirely prevented from accumulating on it; the combined effect of the dust and moisture is to form a semi-conducting film on the surface of the ebonite from one block to another, the result of which is that a certain amount of surface leakage takes place between the two blocks, which should be completely insulated from each other. This leakage is made less by the manner in which the blocks are cut at the ends, but it can only be entirely prevented by keeping that surface quite clean while in use.

Between each pair of blocks a brass plug can fit tightly, so as to form a thoroughly sound electrical connection between them. Two of these plugs, P_1 and P_2, are shown; they are slightly conical, and are screwed into ebonite tops, where they are then pinned to prevent the possibility of their becoming loose. In inserting one of these plugs in the position of P_2 much force should not be employed in order to make a good connection; the plug should be simply placed in the hole, and a slight screwing motion, with gentle force, imparted to it; by this means a thoroughly sound electrical connection will be formed. It is a common and most reprehensible practice of beginners to use considerable force in inserting the plugs in order to procure good contact; it is found most difficult to withdraw such plugs by ordinary means, and the practice invariably results in the operator wrenching the tops off the plugs, and often in his loosening the brass blocks.

The under surface of each block is permanently attached to two stout wires, *w*, *w*, and *w*, which project into the box, and to which are attached the ends of the resistance coils: these coils are wound on the bobbins B B as shown. The bobbins are usually made either of ebonite, or of boxwood which has been thoroughly soaked in melted paraffin wax so as to render them non-conducting; they are kept in position by brass cores, which pass through them, and which are screwed into the ebonite. It would be an improvement to make these bobbins of brass or copper, since these metals would quickly conduct off the heat which is always generated when a current passes through the coils. Ebonite and boxwood are bad conductors of heat, and therefore whatever heat is generated by the coils, instead of being conducted away by the bobbins—as would be the case if they were made of brass or copper—accumulates there, and raises unduly the temperature of the coils, and correspondingly increases their resistance. If the bobbins are made of brass or copper, they must be covered with a layer of paper which has been soaked in melted paraffin wax before the coils are wound on them; this precaution is necessary in order to insure that the wire is thoroughly insulated from the bobbin.

The coils are wound on the bobbins before the latter are placed in position. The wire used for the resistance coils is usually double-silk-covered German silver; and in winding them the following

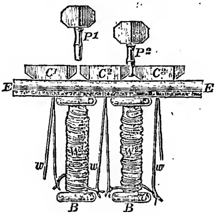


Fig. 1.

method might with advantage be adopted:—Select a piece of wire which has a resistance somewhat greater than is required for the coil you are about to wind; place the ends of this wire together and double it, so as to halve its original length; now wind this double wire on the bobbin as may be seen in W_1 or W_2, Fig. 1. (The necessity for winding the coil double will not be apparent to the student till he comes to the subject of induction; for the present he must be satisfied with the assertion that the necessity actually exists.) The bobbin is now placed in position, and the ends of the resistance coil soldered to the stout wires *w w;* in making this soldering, or in making any soldering that may be necessary in the coils, spirits of salts should on no account be used, since any trace of acid that might remain would inevitably form a little primary battery at the junction, which would render the resistance box perfectly useless for any kind of accurate work, and would ultimately result in the destruction of the joint itself. Common resin is the substance which should always be used when making solderings in any electrical apparatus; it is more troublesome to work with than spirits of salts, but the little extra trouble thus incurred is amply repaid by the certainty of having a resistance box upon whose accuracy we can always depend. The wire as thus wound has a higher resistance than is required, and must therefore be adjusted. (It is here assumed that we can accurately measure a resistance; the best method of doing so will be described later on.) In order to adjust its resistance, a little of the silk covering is removed from the loop that forms the end of the double wire; this loop is then taken in a pair of pliers and twisted, so as to shorten the effective length of the wire. This twisting is continued till the resistance of the wire has been reduced to exactly the required amount, which can be attained with great accuracy. The twisted portion of the wire is now soldered, so as to permanently maintain the true resistance to which it has been adjusted. When the coil has been adjusted, a piece of paraffin paper should be rolled round it, and the coil is usually finished off by having a piece of green silk ribbon rolled round.

The manner in which the box works is obvious from Fig. 1. When a current enters at the block C^1, it cannot reach C^2 without flowing through the coil W^1, provided, of course, that the ebonite surface between C^1 and C^2 is quite clean; but if this surface is covered with the semi-conducting film of dust and moisture, a certain amount of current will leak through this film, thus forming what is known as *surface leakage* between the blocks. The blocks C^2 and C^3 are placed in electrical contact by means of the plug P^2, which is in contact with both; the consequence is that all the current that enters C^2 flows to C^3 through the plug P^2, and none of it passes through the coil W^2 which connects these blocks. Wherever, then, a plug is withdrawn from between two blocks the current is obliged to flow through the coil that connects them; whilst wherever a plug is in position no current flows through the coil corresponding to that plug. If all the plugs are inserted in their holes, there is no resistance opposed to the flow of the current, except that which is offered by the brass blocks and plugs, which is a negligible quantity; if, on the other hand, all the plugs are withdrawn, the current has to flow through all the coils in the box, and has thus to flow through a resistance which is the sum of the resistances of all the coils. In order, therefore, to insert any desired resistance in the path of the current, it is only necessary to withdraw such plugs from their holes that the sum of the resistances corresponding to the withdrawn plugs shall equal the desired resistance.

FRENCH.—XXIII.

[*Continued from p. 219.*]

VERBS.

THE verb is that part of speech which expresses an action done or suffered by the subject, or simply indicates the condition of the subject.

The subject of a verb is the person, animal, or thing doing the action, or being in the condition expressed by the verb. It replies to the question **qui est-ce qui?** *who?* for persons; and **qu'est-ce qui?** *which? what?* for things.

Verbs admit two kinds of objects—the *direct object* and the *indirect object*.

The *direct object* is that which suffers the action expressed by a verb. It answers to the question **qui?** *whom?* for persons; and **quoi?** *what?* for things.

The *indirect object* is that which completes the signification of the verb by means of an intermediate word, such as the prepositions *à*, *de*, *pour*, *avec*, *dans*, etc. It answers to the questions **à qui?** *to whom?* **de qui?** *of* or *from whom?* **pour qui?** *for whom?* **avec qui?** *with whom?* etc., for persons; and **à quoi?** *to what?* **de quoi?** *of* or *from what?* etc., for things.

DIFFERENT SORTS OF VERBS.

There are five sorts of verbs: active, passive, neuter, reflexive or pronominal, and impersonal.

The active verb is that which expresses an action performed by the subject, and suffered by a direct object.

Every French verb after which **quelqu'un**, *someone*, quelque chose, *something*, may be placed, is an active verb. Thus in the following sentences, *protéger*, *changer*, *chanter*, etc., are active verbs, because we may say **protéger quelqu'un**, *to protect someone;* **changer quelque chose**, *to change something:*—

Dieu *protège* l'innocence. RACINE.	*God protects innocence.*
L'habit *change* les mœurs. VOLTAIRE.	*Dress changes the manners*
Les cygnes ne *chantent* pas leur mort. BUFFON.	*Swans do not sing their death.*

The passive verb is the contrary of the active verb. The active verb presents the subject as performing an action immediately directed towards an object; whereas the passive verb presents the subject as suffering or receiving an action performed by the object. The passive verb in French is composed of the past participle of an active verb and the auxiliary *être* (to be).

Nos campagnes *sont fertilisées* par la pluie. L'ACADÉMIE.	*Our fields are fertilised by the rain.*
Il *était guidé* par la force de son génie. MASSILLON.	*He was guided by the force of his genius.*
Les petits esprits *sont trop blessés* des petites choses. LA ROCHEFOUCAULD.	*Little minds are too much vexed with trifles.*

The neuter verb marks, like the active verb, an action performed by the subject; but this action is confined to the subject. Hence, a neuter verb never has a direct object, and the words *quelqu'un* and *quelque chose* cannot be placed after it. A neuter verb can never be used in the *passive voice:*—

Socrate passa le dernier jour de sa vie à *discourir sur* l'immortalité de l'âme. L'ACADÉMIE.	*Socrates spent the last day of his life in discoursing upon the immortality of the soul.*
Le feu qui semble éteint, *dort* souvent *sous* sa cendre. CORNEILLE.	*The fire which seems extinct sleeps often under its ashes.*
Les Platéens citèrent les Lacédémoniens à *comparaître devant* les Amphictyons. LE GENDRE.	*The Plateans summoned the Lacedemonians to appear before the Amphictyons.*

The reflexive or pronominal verb is conjugated with two pronouns of the same person: *je me*, *tu te*, *il se*, *nous nous*, *vous vous*, *ils se*. It expresses—

(1) An action performed and suffered by the subject, and is then called a *pronominal reflexive* verb:—

Je me flatte, *I flatter myself.*	*Vous vous* félicitez, *you congratulate yourselves.*
Il ne faut pas permettre à l'homme de *se mépriser* entièrement. BOSSUET.	*We should not allow men to despise themselves entirely.*

(2) An action reciprocated between two or more subjects, and is then called a *pronominal reciprocal* verb:—

Ils se sont nui.	*They have done harm to each other.*
Ces *enfants se* détestent.	*These children hate one another.*

(3) An action strictly confined to the subject; this is called a *naturally pronominal* verb, and is expressed in English by a transitive or intransitive verb, as the case may be:—

Nous nous souvenons de ce fait.	*We remember that fact.*
Les *ennemis* s'enfuirent.	*The enemy fled.*

The impersonal verb can only be used in the third person singular: **Il pleut**, *it rains;* **il gèle**, *it freezes;* **il tonne**, *it thunders:*—

Pour bien juger les grands, *il faut* les approcher. AUBERT.	*To judge properly of the great, it is necessary to approach them.*
Il faut rendre meilleur le pauvre qu'on soulage. SAINT-LAMBERT.	*We should (it is necessary to) improve the poor whom we relieve.*

There are two verbs called auxiliary, because they serve to conjugate all others. They are— **avoir**, *to have;* and **être**, *to be*.

CONJUGATIONS.

The French verbs are divided into four classes or conjugations, which are chiefly distinguished by the *ending* of the present infinitive:—

(1) The first conjugation comprises all verbs of which the present of the infinitive ends in *-er:* as, **parler**, *to speak;* **aimer**, *to love*, etc. These verbs are derived from Latin verbs which terminate in *-are*.

(2) The second conjugation embraces all those of which the infinitive ends in *-ir:* as, **chérir**, *to cherish;* **punir**, *to punish*, etc. Of the verbs which terminate in *-ir*, some have an imperfect ending in *-issais*, others have an imperfect ending in *-ais*. The former class are derived from Latin verbs ending in *-escere*, the latter from Latin verbs ending in *-ire*. Some grammarians, relying on this distinction, divide verbs in *-ir* into two conjugations.

(3) The third conjugation contains all the verbs which in the infinitive end in *-oir:* as, **devoir**, *to owe;* **avoir**, *to have*, etc. These are for the most part derived from Latin verbs whose infinitive ends in *-ēre*.

(4) The fourth conjugation comprises all the verbs terminating with *-re* in the infinitive: as, **rendre**, *to render;* **prendre,** *to take,* etc. These are derived from Latin verbs whose infinitive ends in *-ere.*

It is a fact worthy of note that the Dictionary of the French Academy contains 4,000 verbs (omitting compound verbs), 3,600 of which end in *-er*, 330 in *-ir* (with an imperfect in *-issais*), 28 in *-ir* (with an imperfect in *-ais*), 40 in *-oir*, and 50 in *-re*.

Considered as words, French verbs present two distinct parts, viz., a *root* or *stem*, and an *ending* or *termination*. The root points out the meaning of the verb; the ending, the tense and the person. Thus, *e.g.*, in *parler*, *parl-*, the root, has the force of *speak;* and *-er*, the ending, points out that it is the present tense of the infinitive.

The verbs are again divided into regular, irregular, and defective:—

(1) The regular verbs are those which, in all their tenses, preserve their *stem or root unaltered.*

(2) The irregular verbs are those which *alter their root,* or have *not* the endings peculiar to their conjugation.

(3) The defective verbs are those which want certain tenses or persons.

Moods and Tenses.

There are five moods: the infinitive, the indicative, the conditional, the imperative, and the subjunctive:—

(1) The infinitive presents the signification of the verb in an unlimited manner. **abandonner ses enfants,** *to abandon one's children.*

(2) The indicative, whatever may be the tense, indicates or declares in a positive, absolute manner: **J'abandonne,** *I abandon;* **J'ai abandonné,** *I have abandoned;* **J'abandonnerai,** *I will abandon.*

(3) The conditional indicates a condition or a supposition: **J'abandonnerais si . . .,** *I would abandon if . . .*

(4) The imperative is used to express a command, prayer or exhortation: **Abandonnez cet enfant,** *abandon that child.*

(5) The subjunctive is used after clauses expressing doubt, contingency, or necessity: **Il est douteux que je l'abandonne,** *it is not certain that I may abandon him.*

The infinitive has two tenses:—

(1) The present	**parler,**	*to speak.*
(2) The past:	**avoir parlé,**	*to have spoken.*

The indicative has eight tenses:—

(1) The present:	**je parle,**	*I speak.*
	je donne,	*I give.*
(2) The simultaneous past, or imperfect:	**je parlais,**	*I was speaking.*
(3) The past definite.	**je parlai,**	*I spoke, I did speak.*
(4) The past indefinite.	**j'ai parlé,**	*I have spoken.*
(5) The pluperfect:	**j'avais parlé,**	*I had been speaking.*
(6) The past anterior:	**j'eus parlé,**	*I had spoken.*
(7) The future absolute:	**je parlerai,**	*I shall, will speak.*
(8) The future anterior or future perfect:	**j'aurai parlé,**	*I shall have spoken.*

The conditional has two tenses:—

(1) The present or future:	**je parlerais,**	*I should, would speak.*
(2) The past:	**j'aurais parlé,**	*I should have spoken.*

The imperative has one tense:—

The present:	**parle,**	*speak.*

The subjunctive has four tenses:—

(1) The present or future:	**que je parle,**	*that I may speak.*
(2) The imperfect:	**que je parlasse,**	*that I might speak.*
(3) The past:	**que j'aie parlé,**	*that I may have spoken.*
(4) The pluperfect:	**que j'eusse parlé,**	*that I might have spoken.*

In addition to the above forms, there are three participles:—

The present participle:	**parlant,**	*speaking.*
The compound present participle:	**ayant parlé,**	*having spoken.*
The past participle:	**parlé,**	*spoken.*

Tenses are simple or compound:—

(1) Simple, when they are expressed in a single word: **Je parle,** *I speak.*

(2) Compound, when they require the assistance of the verb *avoir* or *être:* **J'ai parlé,** *I have spoken,* **Je suis arrivé,** *I am arrived.*

Use of the Auxiliary Verbs Avoir and Être.

The verb *avoir* is used—

(1) As a leading verb, to express possession, obligation, duty: *J'ai* une maison, *I have (I possess) a house;* nous *avons** à travailler, *we have to (must) work.*

(2) As an auxiliary verb, to form—

Its own compound tenses: **J'ai eu,** *I have had.*

The compound tenses of the verb *être:* **J'ai été,** *I have been.*

The compound tenses of the active verbs: **J'ai aimé,** *I have loved.*

The compound tenses of most neuter verbs expressing an action: **J'ai marché,** *I have walked.* (*See* exceptions to this rule below.)

The compound tenses of impersonal verbs: **Il a plu,** *it has rained;* **Il a grêlé,** *it has hailed,* etc.

The verb *être* is used—

(1) As a leading verb, to express existence, condition: *Être,* ou ne pas *être, To be or not to be*—i.e., *to exist or not to exist;* Elle *est* malade, *she is ill:* Ils *sont*,* à plaindre, *they are to be pitied.*

(2) As an auxiliary verb, to form—

All the tenses of passive verbs: **Je suis aimé,** *I am loved.*

* Neither *avoir* nor *être* can be immediately followed by an infinitive; the preposition *à* must be placed before the latter:—Il est *à* travailler, *he is working;* J'ai *à* sortir, *I have to go out.*

The compound tenses of all pronominal verbs: Je me suis flatté, *I have flattered myself;* Je me suis promené, *I have walked.*

The compound tenses of a few neuter verbs, though the same express action:—

aller,	*to go*	naître,	*to be born*
arriver,	*to arrive*	tomber,	*to fall*
choir,	*to fall*	venir,	*to come*
décéder,	*to decease*	parvenir,	*to succeed*
mourir,	*to die*	devenir.	*to become*
revenir,	*to return*, etc.		

NOTE.—Some neuter verbs, which take *être* in their compound tenses, preserve the same auxiliary when they are used impersonally: Il lui est arrivé un malheur, *A misfortune has happened to him.*

A certain number of neuter verbs, as—

accourir,	*to run towards*	entrer,	*to enter*
disparaître,	*to disappear*	sortir,	*to go out*
croître,	*to grow*	passer,	*to pass*
cesser,	*to cease*	partir,	*to depart*
monter,	*to mount, to ascend*	vieillir,	*to grow old*
descendre,	*to go down*	grandir,	*to grow*
rester,	*to remain, to dwell*		

take sometimes *avoir*, and sometimes *être.*

(1) They take *avoir* when the action expressed by the verb is kept in view.

(2) And *être* when situation or condition is the principal idea which it is wished to express:—

EXAMPLES.

With AVOIR.	*With* ÊTRE.
Elle *a* disparu subitement.	Elle *est* disparue depuis quinze jours.
She disappeared suddenly.	*She has been gone a fortnight.*
La fièvre *a* cessé hier.	La fièvre *est* cessée depuis quelque temps.
The fever ceased yesterday.	*It is some time since the fever ceased.*
Le baromètre *a* descendu de plusieurs degrés en peu d'heures.	Il *est* descendu depuis une heure.
The barometer went down several degrees in a few hours.	*He has been down one hour.*
Il *a* passé en Amérique à telle époque.	Les chaleurs *sont* passées.
He went to America at such a time.	*The heat is past.*
Le trait *a* parti avec impétuosité. L'ACADÉMIE.	Les troupes *sont* parties depuis six mois. L'ACADÉMIE.
The dart went off with impetuosity.	*The troops have been gone six months.*
Le sang *avait* cessé de couler. BOISTE.	Ce grand bruit *est* cessé. MME. DE SÉVIGNÉ.
The blood ceased to flow.	*That great noise is now over (has ceased).*

Rester and *demeurer*, meaning *to stay, to dwell, to reside*, take the auxiliary verb *avoir;* when they mean *to remain, to be left*, they take *être:*—

AVOIR.	ÊTRE.
J'*ai* resté plus d'un an en Italie . . . MONTESQUIEU.	Elle donnerait pour vous sa vie, le seul bien qui lui *soit* resté. MARMONTEL.
I resided more than a year in Italy . . .	*She would give for you her life, the only possession which remains to her.*
Il *a* demeuré deux ans à la campagne. L'ACADÉMIE.	Deux cents hommes *sont* demeurés sur le champ de bataille. L'ACADÉMIE.
He lived (dwelt) two years in the country.	*Two hundred men remained on the field of battle.*

Échapper, *to escape, to pass unnoticed, to be forgotten*, takes the auxiliary *avoir.* In the sense of *to say inadvertently* it takes *être:*—

AVOIR.	ÊTRE.
Cette différence ne m'*a* pas échappé. ROUSSEAU.	Ce mot m'*est* échappé: pardonnez ma franchise. VOLTAIRE.
That difference has not escaped me.	*That word escaped my lips; excuse my frankness.*
J'ai retenu le chant, les vers m'*ont* échappé. VOLTAIRE.	Excusez les fautes qui pourront m'*être* échappées. BOILEAU.
I retained the tune, but the verses have escaped my memory.	*Excuse the faults which I may have committed inadvertently.*

Convenir, *to become, to suit*, takes *avoir.* When it is used in the sense of *agreeing*, it takes *être:*—

Cette maison m'*a* convenu.	Nous *sommes* convenus du prix. L'ACADÉMIE.
That house suited me.	*We agreed upon the price.*

The conjugations of the verbs have already been given in previous lessons, and need not be repeated here. If the student wishes to refresh his knowledge of the moods and tenses, we would recommend him to refer back to the earlier lessons, or consult the table of terminations, which we give below.

FORMATION OF THE TENSES.

The tenses of French verbs are divided into *simple* and *compound.* The simple tenses are those which are formed by means of *endings* added to the *stem*, without the help of any auxiliary verb. The compound tenses are those which are composed of the tenses of one of the auxiliaries *avoir* and *être* and the past participle of the leading verb.

Among the simple tenses, five are called *primitive*, because they serve to form the others, which are called *derivative.*

The five primitive tenses are: 1st, the present of the infinitive; 2nd, the present participle; 3rd, the past participle; 4th, the present of the indicative; and 5th, the past definite of the indicative.

The present infinitive forms two tenses, viz., the future of the indicative, and the present of the conditional, as follows:—

1st. The future, by adding to the infinitive the endings of the present indicative of *avoir*, viz.: *-ai, -as, -a, -ons, -ez, -ont:* as, *chanter, je chanter-ai*, etc.; *finir, je finir-ai*, etc.; *recevoir, je recevr-ai*, etc.; *vendre, je vendr-ai*, etc.

NOTE.—Before those endings are added, *oi* must be suppressed from the infinitives of the 3rd Conjugation, and *e* from those of the 4th.

2ndly. The present of the conditional, by adding to the infinitive the endings of the imperfect indicative of *avoir*, viz.: *-ais, -ais, -ait, -ions, -iez, -aient:* as, *chanter, je chanter-ais*, etc.; *finir, je finir-ais*, etc.; *recevoir, je recevr-ais*, etc.; *vendre, je vendr-ais*, etc.

NOTE.—Before those endings are added, *oi* must be suppressed from the infinitives of the 3rd Conjugation, and *e* from those of the 4th.

Three tenses are formed from the present participle, viz.: the plural of the present indicative, the whole of the imperfect indicative, and the present subjunctive, as follows:—

1st. The plural of the present indicative, by changing *-ant* into *ons, -ez, -ent*: as, *chantant, nous chant-ons*, etc.; *finissant, nous finiss-ens*, etc.; *recevant, nous recev-ens*, etc.; *vendant, nous vend-ons*, etc.

NOTE.—In verbs of the 3rd Conjugation, the *e*, which in the present participle precedes *v*, is changed into *oi* in the third person plural of the present indicative: *recevant, ils reçoivent.*

2ndly. The imperfect indicative, by changing *-ant* into *-ais, -ais, -ait, -ions, -iez, -aient*: as, *chantant, je chant-ais*, etc.; *finissant, je finiss-ais*, etc.; *recevant, je recev-ais*, etc.; *vendant, je vend-ais*, etc.

3rdly. The present subjunctive, by changing *-ant* into *-e, -es, -e, -ions, -iez, -ent*: as, *chantant, que je chant-e*, etc.; *finissant, que je finiss-e*, etc.; *recevant, que je reçeiv-e*, etc.; *vendant, que je vend-e*, etc.

NOTE.—In verbs of the 3rd Conjugation, the *e*, which in the present participle precedes *v*, is changed into *oi* in every person of the present subjunctive in which *v* is followed by *-e, -es, -ent*: e.g., *recevant, que je reçoive, que tu reçoives, qu'il reçoive, qu'ils reçoivent*; but this change does not occur in the first two persons plural, in which *v* does not precede *e* mute: *que nous recevions, que vous receviez.*

The past participle forms all the compound tenses by being added to the various tenses of *avoir* or *être*: as, *j'ai chanté, je suis allé, il avait dîné, ils étaient partis*, etc.

The present indicative forms the imperative by leaving out in the latter the pronouns *je, nous*, and *vous*: as, *je chante, chante; nous finissons, finissons; vous recevez, recevez.*

NOTE.—The French imperative has no third person; that which is given in this work, for the convenience of students, belongs to the present subjunctive.

From the past definite of the indicative is formed the perfect subjunctive by adding to the *second person singular* of the former the following endings: *-se, -ses, -sions, -siez, -sent*: as, *tu chantas, que je chantas-se*, etc.; *tu finis, que je finis-se*, etc.; *tu reçus, que je reçus-se*, etc.; *tu vendis, que je vendis-se*, etc.

As to the third person singular of the imperfect subjunctive, it is also formed from the second singular of the past indicative, but by changing the final *s* of the latter into *t*, and putting a circumflex accent on the foregoing vowel: as, *tu chantas, qu'il chantât; tu finis, qu'il finît; tu reçus, qu'il reçût; tu vendis, qu'il vendît.*

THE PARTICIPLE.

The participle is so called because it participates of the nature both of the verb and of the adjective. It partakes of the nature of the verb, in having its signification and an object, and of the nature of the adjective in qualifying, like the latter, nouns and pronouns.

There are in French two sorts of participles, the present and the past.

In a previous lesson we have told you something of the participles, and we only add a few examples here for the sake of completeness.

THE PARTICIPLE PRESENT.

The participle present, which denotes continuance of action, answers to the English participle in *-ing.*

This participle is invariable, always terminating in *-ant*; as, chantant, *singing*; finissant, *finishing*; recevant, *receiving*; vendant, *selling*:—

une dame *marchant*,	*a lady walking.*
des hommes *marchant*,	*men walking.*
J'ai vu les vents *grondant* sur ces moissons superbes, Déraciner les blés, se disputer les gerbes. DELILLE.	*I have seen the winds roaring over those superb harvests, root up the grain, and contend for the sheaves.*

VERBAL ADJECTIVES ENDING IN -ANT.

The present participle is often used adjectively to express a quality or a condition of a noun. In this case it agrees as an adjective, and forms its feminine and its plural as the latter. Present participles used adjectively are called *verbal adjectives*; they never denote action.

PARTICIPLES PRESENT USED

To denote Quality.	*To denote Action.*
Une femme *obligeante* est aimée de tout le monde.	Une femme *obligeant* tout le monde est généralement aimée.
An obliging woman is loved by everybody.	*A woman obliging everybody is generally loved.*
Il n'y a que les natures *aimantes* qui soient propres à l'étude de la nature. BERNARDIN DE ST. PIERRE.	Les natures *aimant* la solitude aiment généralement l'étude.
Affectionate natures (dispositions) only are fit for the study of nature.	*Natures (dispositions) loving solitude are in general fond of study.*

Verbal adjectives generally follow their noun.

THE PARTICIPLE PAST.

The participle past denotes the completion of the action.

It is susceptible of variations for gender and number.

The participle past, used without an auxiliary, agrees, like an adjective, in gender and number with the noun which it qualifie

Past participles used adjectively follow their noun: the only exception to this rule being the participle *prétendu*, which is always placed before the noun it qualifies:—

des enfants *chéris*,	*beloved children*.
des femmes *estimées*,	*esteemed women*.
la *prétendue* marquise,	*the self-styled marchioness*.
Comme une lampe d'or dans l'azur *suspendue*, La lune se balance aux bords de l'horizon; Ses rayons *affaiblis* dorment sur le gazon. LAMARTINE.	*Like a golden lamp suspended in the azure vault, the moon balances herself in the confines of the horizon; her weakened rays sleep on the turf.*

KEY TO TRANSLATION (p. 219).

PROSE AND VERSE.

M. Jourdain.—I must take you into my confidence. I am in love with a person of high rank, and I should desire you to help me to write something to her in a little love-letter which I wish to let fall at her feet.

The Philosophy Master.—Very good!

M. Jourdain.—Yes; that will be graceful.

The Philosophy Master.—Doubtless. Are they verses which you wish to write to her?

M. Jourdain.—No, no; not verses.

The Philosophy Master.—You only wish for prose.

M. Jourdain.—No; I wish for neither prose nor verse.

The Philosophy Master.—It must be either the one or the other.

M. Jourdain.—Why?

The Philosophy Master.—For the reason, sir, that there is no other way in which to express oneself but in prose or verse.

M. Jourdain.—There is nothing else but prose or verse?

The Philosophy Master.—No, sir. Everything which is not prose is verse, and everything which is not verse is prose.

M. Jourdain.—And when one speaks, what is that then?

The Philosophy Master.—Prose.

M. Jourdain.—What! when I say, "Nicole, bring me my slippers, and give me my nightcap," it is prose?

The Philosophy Master.—Yes, sir.

M. Jourdain.—By my faith! For more than forty years I have been speaking prose without knowing anything about it; and I am the most obliged in the world for having learnt that. I should wish then to put for her in a love-letter: "Beautiful marchioness, your lovely eyes make me die of love," but I want that to be put in an elegant manner, and to be prettily turned.

The Philosophy Master.—Put that the fires of her eyes reduce your heart to a cinder, and that you suffer night and day for her the violence of a ——

M. Jourdain.—No, no, no; I do not want that at all. I only want what I have told you: "Beautiful marchioness, your lovely eyes make me die of love."

The Philosophy Master.—You might extend the thing a little.

M. Jourdain.—No, I tell you; I only wish these words alone in the love-letter, but turned in the fashion, well arranged, as they ought to be. I beg you to tell me a little, so as to see the different ways in which you can put them.

The Philosophy Master.—You can put them first as you have said: "Beautiful marchioness, your lovely eyes make me die of love"; or, again, "To die of love, beautiful marchioness, your lovely eyes make me"; or, again: "To die, your lovely eyes, beautiful marchioness, of love make me"; or, again. "Your lovely eyes make me, beautiful marchioness, to die of love."

M. Jourdain.—But, of all those ways, which is the best.

The Philosophy Master.—The one you have said: "Beautiful marchioness, your lovely eyes make me die of love."

M. Jourdain.—Yet I have never studied, and I did all that at the first trial. I thank you with all my heart, and I beg you to come again to-morrow in good time.

The Philosophy Master.—I will not fail to be there.

ACT II., SCENE II., "LE BOURGEOIS GENTILHOMME."

ALGEBRA.—V.

[*Continued from p. 223.*]

LEAST COMMON MULTIPLE.

114. A *common multiple* of two or more quantities is a quantity which can be divided by each of them without a remainder. Thus $12ab$ is a common multiple of $4a$ and $6b$: or of $3a$ and $2b$, etc.

115. The least common multiple of two or more quantities is the least quantity which can be divided by each of them without a remainder. Thus $12abc$ is the least common multiple of $4a$, $3b$, and $6c$.

116. To find the least common multiple of two or more given quantities.

Rule.—Reduce the given quantities to their prime factors; find the product of the greatest powers of these factors, and it will be the least common multiple required.

EXAMPLE.—Find the least common multiple of $(a+x)^2$, a^2-x^2, and $(a-x)^2$.

Here, the prime factors of the quantities are $(a+x)^2$, $(a+x)$, $(a-x)$, and $(a-x)^2$; now of these factors, which are different powers of $a+x$ and $a-x$, the first and last contain their highest powers; therefore, according to rule, $(a+x)^2(a-x)^2 = (a^2-x^2)^2$ is the least common multiple of the quantities required.

EXERCISE 12.

1. Find the least common multiple of bc, ce, and bg.
2. Find the least common multiple of a^2b^3 and a^3b^2.
3. Find the least common multiple of $2ab$, $3bc$, $4cd$, $5de$, and $6ef$.
4. Find the least common multiple of $(a+b)^2$, (a^2-b^2), $(a-b)^2$, and $(a-b)^3$.
5. Find the least common multiple of $6a$, $9a^3$, and $4a^2$.
6. Find the least common multiple of a^3-x^3 and a^2-x^2.
7. Find the least common multiple of $(x-a)$, $(x+a)$, (x^2-a^2), and (x^2+a^2).

FRACTIONS.

117. FRACTIONS *in algebra*, as well as in arithmetic, have reference to *parts* of numbers or quantities. The term is derived from the Latin word *fractio*, which signifies a *breaking* into parts.

Thus, $\frac{a}{2}$ is $\frac{1}{2}a$; $\frac{b}{4}$ is $\frac{1}{4}b$; $\frac{2a}{3}$ is $\frac{2}{3}a$; and $\frac{4x}{7}$ is $\frac{4}{7}x$.

118. Expressions in the form of fractions occur more frequently in algebra than in arithmetic. Indeed, the numerator of *every* fraction may be considered as a *dividend*, of which the denominator is a *divisor*.

119. The *value* of a fraction is the *quotient* of the numerator divided by the denominator. Thus, the value of $\frac{6}{2}$ is 3; the value of $\frac{ab}{a}$ is a; and the value of $\frac{aa-bb}{a-b}$ is $a+b$.

120. From this it is evident that whatever changes are made in the *terms* of a fraction, if the *quotients* be not altered, the value of the fraction remains the same. For any fraction, therefore, we may substitute any *other* fraction which will give the same quotient.

Thus, $\frac{4}{2}=\frac{10}{5}=\frac{4ba}{2ba}=\frac{8drx}{4drx}=\frac{6+2}{3+1}$ etc.; for the quotient in each of these instances is 2.

121. It is also evident, from the preceding articles, that *if the numerator and denominator be both multiplied, or both divided, by the same quantity, the value of the fraction will not be altered.* Thus, $\frac{4}{5}=\frac{36}{45}$, each term being multiplied by 9; and $\frac{36}{45}=\frac{9}{12}=\frac{3}{4}$, each term being divided by 3, and the result by 3 again.

So $\frac{bx}{b}=\frac{abx}{ab}=\frac{3bx}{3b}=\frac{\frac{1}{2}bx}{\frac{1}{2}b}=\frac{\frac{1}{3}abx}{\frac{1}{3}ab}$; for the quotient in each case is x.

122. Any integral quantity may, without altering its value, be expressed in the form of a fraction, *by making unity or 1 the denominator; or by multiplying the quantity into any proposed denominator, and making the product the numerator of the fraction required.* Thus, $a=\frac{a}{1}=\frac{ab}{b}=\frac{ad+ah}{d+h}=\frac{6adh}{6dh}$; the quotient of each of these being a.

Also $d+h=\frac{dx+hx}{x}$; and $r+1=\frac{2drr+2dr}{2dr}$.

ON THE SIGNS OF FRACTIONS.

123. *Each sign* in the numerator and denominator of a fraction affects only the *single* term to which it is prefixed. The *dividing line* answers the purpose of a parenthesis or *vinculum*, namely, to connect the several terms of which the numerator and denominator may each be composed. The *sign prefixed* to it, therefore, affects the *whole* fraction collectively and every term individually. It shows that the *value* of the whole fraction, and of course every term, is to be subjected to the operation denoted by the sign. Hence, *if the sign before the dividing line be changed from + to −, or from − to +, the value of the whole fraction is also changed.*

Thus it is plain that the value of $\frac{ab}{b}$ is a. [Art. 111.] But this will become *negative* if the sign − is prefixed to the fraction. Hence, $y+\frac{ab}{b}=y+a$. But $y-\frac{ab}{b}=y-a$.

124. In performing fractional operations there is frequent occasion to remove the denominator of the fraction; also to incorporate a fraction with an integer, or with another fraction. In *each* of these cases, if the sign − is prefixed to the dividing line, *the signs of all the terms of the numerator must be changed*, as in Art. 64, where a parenthesis, having the sign − before it, is removed.

Thus $b-\frac{ad+ah}{a}=b-d-h$; and $b-\frac{ad-ah}{a}=b-d+h$.

Next, *if all the signs of all the terms in the numerator of a fraction are changed, the value of the fraction is changed in the same manner.* Thus, $\frac{ab}{b}=+a$ [Art. 101]; but $\frac{-ab}{b}=-a$. And $\frac{ab-bc}{b}=a-c$; but $\frac{-ab+bc}{b}=-a+c$.

Again, *if all the signs of all the terms in the denominator of a fraction are changed, the value of the fraction is also changed.*

Thus, $\frac{ab}{b}=+a$; but $\frac{ab}{-b}=-a$.

125. *If then the sign prefixed to a fraction, or the signs of all the terms of the numerator, or the signs of all the terms of the denominator, be changed, the value of the fraction will be changed from positive to negative, or from negative to positive.*

126. *If the same change be made upon the numerator and denominator of a fraction at the same time, they will balance each other, and the value of the fraction will not be altered.* Thus, by changing the sign of the numerator, the fraction $\frac{ab}{b}=+a$ becomes $\frac{-ab}{b}=-a$. But by changing the signs of both the numerator and the denominator, it becomes $\frac{-ab}{-b}=+a$, where the original value is restored. By changing the sign before the fraction, the expression $y+\frac{ab}{b}=y+a$ becomes $y-\frac{ab}{b}=y-a$. But by changing the sign of the numerator also, it becomes $y-\frac{-ab}{b}$, where the quotient $-a$ is to be subtracted from y, or which is the same thing [Art. 58], $+a$ is to be *added*, making the

value $y+c$ as at first. In like manner, $\frac{6}{2}=\frac{-6}{-2}=-\frac{-6}{2}=-\frac{6}{-2}=+3$. And $\frac{6}{-2}=\frac{-6}{2}=-\frac{6}{2}=-\frac{-6}{-2}=-3$. Hence the quotient in division may be set down in different ways and still have the same value. Thus $(a-c)\div b$ is either $\frac{a}{b}\div\frac{-c}{b}$, or $\frac{a}{b}-\frac{c}{b}$.

REDUCTION OF FRACTIONS.

127. A FRACTION *may be reduced to lower terms by dividing both the numerator and denominator by any quantity which will divide them without a remainder: or by throwing out any factor common to both.* According to Art. 121, this process will not alter the *value* of the fractions.

EXAMPLE.—Reduce $\frac{ab}{cb}$ to lower terms. *Ans.* $\frac{a}{c}$.

128. If the same letter or combination of letters is in *every* term, both of the numerator and denominator, it may be *cancelled*, for this is *dividing* by that letter or combination of letters. [Art. 98.]

EXAMPLE.—Reduce $\frac{3am+ay}{ad+ah}$ to lower terms. *Ans.* $\frac{3m+y}{d+h}$.

129. If the numerator and denominator be divided by the *greatest common measure*, it is evident that the fraction will be reduced to the *lowest* terms.

EXAMPLE.—Reduce $\frac{5a^4}{3a^2}$ to its lowest terms.

Here, $\frac{5a^4}{3a^2}=\frac{5aaaa}{3aa}=\frac{5aa}{3}$. *Ans.*

EXERCISE 13.

Reduce the following fractions to lower terms:—

1. $\frac{6dm}{5dy}$.
2. $\frac{7m}{7mr}$.
3. $\frac{a+bc}{(a+bc)\times m}$.
4. $\frac{am+ay}{bm+by}$.
5. $\frac{dry+dy}{dhy-dy}$.

EXERCISE 14.

Reduce the following fractions to their lowest terms:—

1. $\frac{6x^6}{8x^5}$.
2. $\frac{8a^4+4a^6}{3a^3}$.
3. $\frac{8a^3y-12a^2y^2+6ay^3}{6a^2y+4ay^2}$.
4. $\frac{x^3+a^3}{x^2+2ax+a^2}$.
5. $\frac{x^3-a^3}{ax-a^2}$.
6. $\frac{8a^3-27b^3}{4a^2-9b^2}$.
7. $\frac{3x^5+2x^4-x^3-x^2+2x+3}{x^3-5x^2-5x+1}$.
8. $\frac{x^4-x^3-2x+2}{2x^3-x-1}$.
9. $\frac{18x^4-5x^3+44x-5}{3x^4+20x^3-57x^2+80x-50}$.
10. $\frac{16x^4-53x^2+45x+6}{8x^4-30x^3+31x^2-12x}$.
11. $\frac{24x^5-22x^4-14x^3+24x^2-8x}{18x^6-18x^4-14x^3\times 30x^2-12x}$.

130. To reduce fractions of different denominators to fractions having a common denominator.

Multiply together each numerator and all the denominators except its own, and the product will be the required numerator of each fraction: next, multiply together all the denominators, and the product will be the required denominator of each fraction; these properly arranged in order will give the answer.

EXAMPLE.—Reduce $\frac{a}{b}$, $\frac{c}{d}$, and $\frac{m}{y}$ to fractions having a common denominator.

Here, $a\times d\times y=ady$,
$c\times b\times y=bcy$,
and $m\times b\times d=bdm$, are the three numerators.
Also $b\times d\times y=bdy$, is the common denominator.

Hence, the reduced fractions are $\frac{ady}{bdy}$, $\frac{bcy}{bdy}$, and $\frac{bdm}{bdy}$. *Ans.*

The reason of this rule is plain, for the reduction consists in multiplying the numerator and denominator of each fraction into all the other denominators, a process which does not alter the value of the fractions. [*See* Art. 121.]

131. An *integer* and a fraction are easily reduced to fractions having a common denominator, by making the former a fraction. [*See* Art. 122.]

EXAMPLE.

Reduce a and $\frac{b}{c}$ to fractions having a common denominator.

Here, a and $\frac{b}{c}$, are equal to $\frac{a}{1}$ and $\frac{b}{c}$, which are equivalent to $\frac{ac}{c}$ and $\frac{b}{c}$, the fractions having a common denominator.

EXERCISE 15.

1. Reduce $\frac{dr}{3m}$, $\frac{2h}{g}$, and $\frac{dc}{y}$ to fractions having a common denominator.

2. Reduce $\frac{2}{a}$, $\frac{a}{x}$, and $\frac{r+1}{d+h}$ to fractions having a common denominator.

3. Reduce $\frac{1}{a+b}$, and $\frac{1}{a-b}$ to fractions having a common denominator.

4. Reduce a, b, $\frac{h}{n}$, and $\frac{d}{y}$ to fractions having a common denominator.

5. Reduce $\frac{n}{b}$, $\frac{c}{d}$, and $\frac{e}{f}$ to fractions having a common denominator.

6. Reduce $\frac{3x}{a}$, $\frac{y}{5b}$, and $\frac{1}{2}$ to fractions having a common denominator.

7. Reduce b, $\frac{x}{y}$, and $\frac{c}{2}$ to fractions having a common denominator.

8. Reduce $\frac{x}{a}$, $\frac{b}{z}$, $\frac{3c}{y}$, and $\frac{1}{3}$ to fractions having a common denominator.

9. Reduce $\frac{3x}{a}$, $\frac{b}{4c}$, and $\frac{x}{5}$ to fractions having a common denominator.

10. Reduce $\frac{a}{b}$, $\frac{5}{7}$, $\frac{8x}{y}$, and $\frac{1}{4}$ to fractions having a common denominator.

11. Reduce $\frac{4a}{x}$, 17, $\frac{y}{c}$, x, and $\frac{c}{4a}$ to fractions having a common denominator.

12. Reduce $\frac{1}{a^2b^3}$ and $\frac{1}{a^3b^2}$ to fractions having a common denominator.

13. Reduce $\frac{a}{x^3 + x^2 + x + 1}$ and $\frac{1}{x - 1}$ to fractions having a common denominator.

14. Reduce $\frac{r - a}{x^2 - ax + a^2}$ and $\frac{1}{x + a}$ to fractions having a common denominator.

15. Reduce $\frac{1}{2ab}$, $\frac{2}{3bc}$, $\frac{3}{4cd}$, $\frac{4}{5de}$, and $\frac{5}{6ef}$ to fractions having a common denominator.

132. To reduce an improper fraction to a whole or mixed quantity.

Divide the numerator by the denominator, the quotient with the remainder in a fractional form is the answer. [*See* Art. 106.]

133. To reduce a mixed quantity to an improper fraction.

Multiply the integer by the given denominator, and add the given numerator to the product. [*See* Art. 122.] *The sum will be the required numerator; and this placed over the given denominator will form the improper fraction required.*

If the sign before the dividing line is —, all the signs in the numerator must be changed. [*See* Art. 124.]

Exercise 16.

1. Reduce $\frac{ab + bm + d}{b}$ to a whole or mixed quantity.
2. Reduce $\frac{am - a + adn - br}{a}$ to a whole or mixed quantity.
3. Reduce $a + \frac{1}{b}$ to an improper fraction.
4. Reduce $a - \frac{b}{c}$ to an improper fraction.
5. Reduce $ab - \frac{a - c}{x}$ to an improper fraction.
6. Reduce $m + d - \frac{r}{h - d}$ to an improper fraction.
7. Reduce $x - \frac{a + b}{c}$ to an improper fraction.
8. Reduce $ax + \frac{a - b}{d}$ to an improper fraction.
9. Reduce $b - \frac{c}{d - y}$ to an improper fraction.
10. Reduce $x^2 + ax + a^2 + \frac{a^3}{x - a}$ to an improper fraction.
11. Reduce $2x - 4a + \frac{7a^2}{x + 2a}$ to an improper fraction.
12. Reduce $3a - 4x + \frac{25ax - 12x^2}{4a - 3x}$ to an improper fraction.
13. Reduce $1 - \frac{x - a}{x + a}$ to an improper fraction.

134. To reduce a compound fraction to a simple one.

Multiply all the numerators together for a new numerator, and all the denominators for a new denominator.

Exercise 17.

1. Reduce $\frac{2}{7}$ of $\frac{a}{b + 2}$ to a simple fraction.
2. Reduce $\frac{2}{3}$ of $\frac{4}{5}$ of $\frac{b + h}{2a - m}$ to a simple fraction.
3. Reduce $\frac{a^2}{b}$ of $\frac{c^3}{d^2}$ of $\frac{c^4}{f^3}$ to a simple fraction.
4. Reduce $\frac{a^2}{b}$ of $\frac{b^3}{c^2}$ of $\frac{c^4}{d^3}$ to a simple fraction.
5. Reduce $\frac{x^2 - ax + a^2}{x^2 + ax + a^2}$ of $\frac{x + a}{x - a}$ to a simple fraction.
6. Reduce $\frac{3x^2 - 4x + 1}{x^2 + 4x - 3}$ of $\frac{3x + 4}{x - 4}$ to a simple fraction.
7. Reduce $\frac{1}{7}$ of $\frac{1}{3}$ of $\frac{1}{8 - a}$ to a simple fraction.
8. What is the value of $\frac{8aay}{2aay}$?
9. What is the value of $\frac{aabbccddff}{abcdf}$?
10. What is the value of $\frac{ab}{a} \times 4$?
11. What is the value of $\frac{16axy}{a} \div 4x$?
12. What is the value of $\frac{16ax}{2a}$ when the denominator is *multiplied by* 4?
13. What is the value of $\frac{3axy}{24ax}$ when the denominator is *divided by* $6ax$?
14. What is the value of $\frac{17abx}{34a}$ when both numerator and denominator are $\times\ 2d$?
15. Reduce $\frac{6abc + 12abx}{2ab}$ to a whole or mixed number.
16. Reduce $\frac{24xy - 48ax}{12x}$ to a whole number.
17. Reduce $\frac{ab + e + dx + ax + am}{a}$ to a whole or mixed number.
18. Reduce the four next examples to their lowest terms :—

    (1) $\frac{abc}{aac}$. (2) $\frac{3xy}{12xyy}$. (3) $\frac{bx + by}{ab + bx}$. (4) $\frac{aaxy - aab}{ac + abc}$.
19. Reduce $\frac{ax}{y}$ and $\frac{c}{d}$ to a common denominator.
20. Reduce $\frac{a}{b}$, $\frac{c}{d}$, $\frac{f}{g}$, and $\frac{x}{y}$ to a common denominator.
21. Reduce $a - \frac{b + c}{x}$ to an improper fraction.
22. Reduce $a + b - \frac{x - y}{4m}$ to an improper fraction.
23. Reduce $\frac{2}{3}$ of $\frac{a}{b}$ of $\frac{c}{d}$ of $\frac{x}{y}$ to a simple fraction.
24. Reduce $\frac{2}{7}$ of $\frac{2x}{4b}$ of $\frac{4ab}{2}$ of $\frac{2c}{4x}$ of $\frac{4dx}{2a}$ of $\frac{abc}{2d}$ to a simple fraction.

ADDITION OF FRACTIONS.

To add fractional quantities together.

135. *Rule.—Reduce the given fractions to fractions having a common denominator if necessary;*

then add their numerators, and place the sum over the common denominator.

EXAMPLES.—(1) Add $\frac{2}{16}$ and $\frac{4}{16}$ of a pound.

Ans. $\frac{2+4}{16}$ or $\frac{6}{16} = \frac{3}{8}$ of a pound.

(2) Add $\frac{a}{b}$ and $\frac{c}{d}$ together.

Here, reducing them to a common denominator, they become $\frac{ad}{bd}$ and $\frac{bc}{bd}$, whence their sum is $\frac{ad+bc}{bd}$. *Ans.*

136. For many purposes, it is sufficient to add fractions in the same manner as integers are added, by writing them one after another with their proper signs.

EXAMPLE.—Find the sum of $\frac{a}{b}$, $\frac{3}{y}$, and $-\frac{d}{2m}$.

Here the sum is simply $\frac{a}{b} + \frac{3}{y} - \frac{d}{2m}$. *Ans.*

137. To add fractions and integers together.

Write them one after another with their signs: or convert the integers into fractions, reduce the fractions to a common denominator, and then add as before.

EXERCISE 18.

1. Find the sum of $\frac{m}{d}$ and $-\frac{2r+d}{3h}$.
2. Find the sum of $\frac{a}{d}$ and $-\frac{b-m}{y}$.
3. Find the sum of $\frac{a}{y}$ and $-\frac{d}{m}$.
4. Find the sum of $\frac{a}{a+b}$ and $\frac{b}{a-b}$.
5. Add $\frac{-a}{d}$ to $\frac{-h}{m-r}$.
6. Add $\frac{-4}{2}$ to $\frac{-16}{7-3}$.
7. Add $\frac{4a}{b}$, $\frac{6c}{d}$, and $\frac{3m}{3r}$ together.
8. Add $\frac{2xy}{2}$, $\frac{hx}{y}$, and $\frac{ax}{c} + \frac{2}{a}$ together.
9. Add $a + \frac{b}{2}$, $c + \frac{d}{x}$, xy, and $\frac{a-b}{4}$ together.
10. Add $42 - \frac{2b}{c}$, $a - \frac{b+c}{3x}$, and $a + \frac{b+c}{3x}$ together.
11. Add $\frac{3a}{2c} - \frac{x-y}{c}$, $\frac{a}{2c}$, $\frac{xyy}{xy}$, and $\frac{8ab}{4c}$ together.
12. Add $2a + x\frac{8x+10}{2}$, and $-\frac{3bx+4b}{b}$ together.
13. What is the sum of a and $\frac{b}{m}$?
14. What is the sum of $3d$ and $\frac{h+d}{m+y}$?
15. What is the sum of $5x$ and $\frac{a+3b}{c}$?

SUBTRACTION OF FRACTIONS.

138. *Rule.—Change the sign of the subtrahend, that is, of the fraction to be subtracted; and then proceed as in addition of fractions.*

EXAMPLE.—From $\frac{a}{b}$ subtract $\frac{h}{m}$.

Here, reducing the fractions to a *common denominator*, they become $\frac{am}{bm}$ and $\frac{bh}{bm}$. Now, changing the sign of the subtrahend, we have $\frac{am}{bm} - \frac{bh}{bm}$; then, proceeding as in addition of fractions we have $\frac{am}{bm} - \frac{bh}{bm} = \frac{am-bh}{bm}$. *Ans.*

EXERCISE 19.

1. From $\frac{a+y}{r}$ subtract $\frac{h}{d}$.
2. From $\frac{a}{m}$ subtract $\frac{d-b}{y}$.
3. From $\frac{cd}{a}$ subtract $\frac{d+b}{ab}$.
4. From $\frac{a+3d}{4}$ subtract $\frac{3a-2d}{3}$.
5. From $\frac{b-d}{m}$ subtract $-\frac{b}{y}$.
6. From $\frac{a+1}{d}$ subtract $\frac{d-1}{m}$.

139. Fractions may also be subtracted, like integers, by setting them down, when the sign of the subtrahend is changed, one after the other, without reducing them to a common denominator.

EXAMPLE.—From $\frac{h}{m}$ subtract $-\frac{h+d}{y}$.

Ans. $\frac{h}{m} + \frac{h+d}{y}$.

140. To subtract an integer from a fraction, or a fraction from an integer.

Change the sign of the subtrahend, and write it after the minuend; or, put the integer into the form of a fraction, and then proceed according to the general rule for subtraction of fractions.

EXAMPLE.—From $2 + \frac{a}{c}$ subtract $3 + b$.

Ans. $\frac{a}{c} - b - 1$.

EXERCISE 20.

1. From $\frac{h}{y}$ subtract m.
2. From $4a + \frac{b}{c}$ subtract $3a - \frac{h}{d}$.
3. From $1 + \frac{b-c}{d}$ subtract $\frac{c-h}{d}$.
4. From $a + 3h - \frac{d-h}{2}$ subtract $3a - h + \frac{d-b}{3}$.
5. From $\frac{a-x}{b}$ take $\frac{d+y}{c}$.
6. From $\frac{a+b}{x}$ take $\frac{c-d}{y}$.
7. From $\frac{a}{b-x}$ take $\frac{c}{d+y}$.
8. From $a - \frac{x}{y}$ take $\frac{3d}{2}$.
9. From $x + y$ take $\frac{a-b}{c}$
10. From $\frac{x-y}{10}$ subtract $\frac{a-b}{x+y}$.
11. From $x - \frac{4y-2c}{2}$ take $\frac{3x-6y}{3} + a$.
12. From $\frac{1}{x}$ subtract $\frac{2}{y}$.
13. From $\frac{1}{x}$ subtract $\frac{1}{2y}$.
14. From $\frac{a^2}{xy}$ subtract $\frac{b^2}{y^2}$.
15. From $\frac{1}{a^3b^2}$ subtract $\frac{3}{a^2b^3}$.
16. From $\frac{1}{x}$ subtract $\frac{1}{x+1}$.
17. From $7x - \frac{a^2}{b}$ take $3x - \frac{a^3}{b^2}$.
18. From $\frac{x+y}{x-y}$ subtract $\frac{x-y}{x+y}$.
19. From 1 subtract $\frac{x^2-y^2}{x^2+y^2}$.

KEY TO EXERCISES.

Exercise 7.

1. $\frac{hx}{y}$.
2. $\frac{hm-3y}{b}$.
3. $\frac{a+x}{y}$.
4. $\frac{am}{xy}$.
5. $dy+r-\frac{hd}{x}$.
6. $2h+d+\frac{x}{a}$.
7. $-m-\frac{3y}{b}$
8. $y+\frac{dh}{2m}$.
9. 1.
10. 1.
11. 1.
12. $a+1$.
13. $b-1$.
14. $xy-1+2d$.
15. $ab+1-2m$.
16. 5.
17. $\frac{1}{3}$.

Exercise 8.

1. $x-y$.
2. $a-b$.
3. $b+c$.
4. $aa-ax+xx$.
5. $x-ax+3aax$.
6. $1-x$.
7. $c+d+\frac{x}{a+b}$.
8. $a+b+\frac{y}{d-h}$.

Exercise 9.

1. $2ay+ax-3bm+4$.
2. $4a-3+2y+1-5adx+\frac{1}{4}m$.
3. x.
4. a.
5. $-x-d-1+\frac{ry+4my+6}{a}$.
6. $\frac{x-a-3}{d}-\frac{a}{dy}+\frac{1}{my}$.
7. $\frac{1}{3}-\frac{3}{rd}+\frac{1}{ad}-\frac{b}{2ar}+\frac{3}{ard}$.
8. $\frac{3}{2}y-\frac{2}{axy}+\frac{1}{2a}+\frac{1}{axy}-\frac{3h}{2ax}$.
9. $4cx-3xy+6xd-9hg$.
10. $3by+6cdx+2a-5aab$.
11. $4z-2hd+8m$.
12. $a-12b+\frac{14}{x}-24c+10a$.
13. $-10ab+(x+y)-18-3(a+b)-12c$.
14. x.
15. 2.
16. $b+d-x(a+b)+42xy-b$.
17. $3+\frac{5h}{m}-\frac{10}{am}+\frac{6cd}{am}-\frac{17}{2m}$.
18. $\frac{1}{6}+\frac{1}{yz}+\frac{1}{3xy}-\frac{1}{6xyz}+\frac{1}{3}(a+b)$.
19. $\frac{1}{b}+\frac{2}{a}+\frac{1}{c}+\frac{5}{3abc}+\frac{1}{3}abc$.
20. $9ayx+8ax-10bcm+12a$.
21. $-4x+6-2a-21+5ax+\frac{a}{4}$.
22. h.
23. $x+y$.
24. x.
25. $2b+\frac{2}{a}$.
26. $2x-b+c+\frac{h}{3a+y}$.
27. $aa+2a-4$.
28. $b+2c$.
29. $4a^2+2ab+b^2$.
30. $x^2-2ax+a^2$.
31. $2y^2-3y+2$.
32. $x^5+x^4+x^3+x^2+x+1$.
33. $2xx-3x+1-\frac{2}{2x^2+3x-1}$.

Exercise 10.

1. bc^2 and x^4y^4.
2. x^n and x^{m-2n}.
3. x^2-ax+a^2.
4. $\frac{2}{3}a^3-a^2y-2ay^2$.
5. a^2b-2ab^2.
6. x^3-3ax^2.
7. $x^2+3xy-2y^2$.
8. x^2-3x-2.
9. $x+a+\frac{2a^2}{x-a}$
10. $a+b-c$.
11. $27x^3-18x^2+12x$.
12. $x-\frac{a^2x-a^3}{x^2+a^2}$.
13. $2y^2-3ay-2a^2-\frac{5a^3y^3-2a^3y^2}{5y^3-4ay^3+a^2y^2}$.
14. $7x-5$.
15. $2x^3+5x^2y+22xy^2+88y^3+\frac{353y^4}{x-4y}$
16. $x^3-2x^2+3x-4+\frac{5x+4}{x^2+2x+1}$.
17. $x^3+2x^2+3x+4+\frac{5x-4}{x^2-2x+1}$.
18. $x^2+3x+7+\frac{7x-7}{x^2-3x+2}$.
19. $5x^2-ax-6a^2-\frac{3a^3x-5a^4}{x^2-ax+a^2}$.
20. $x^3+3x^2v+3xv^2+v^3$.
21. $3x^3-9x^2+2x-1$.
22. $3a^2b+2ab^2-2b^2c-3bc^2$.
23. $a^2+ab+b^2+bc+c^2-ac$.
24. $2x^3-3x^2+2x$.
25. $x+2x^2+3x^3+4x^4+5x^5+6x^6+7x^7+8x^8$.

Exercise 11.

1. $x+b$.
2. $c+x$.
3. x^3-8x-3.
4. a^2-b^2.
5. $x+1$.
6. $x-a$.
7. $a-2b$.
8. a^2-x^2.
9. $a+b$.

BOTANY.—XIII.

[Continued from p. 257.]

THE FRUIT (continued).

All inferior fruits must be, as we have seen, to some extent pseudocarps, the adherent receptacular tube forming their external parts. There are six principal types of inferior syncarpous fruits, three dry and three more or less succulent. The three dry forms are the cypsela, the nut, and the cremocarp; the three succulent forms, the berry, the pepo, and the pome.

The *cypsela* (Greek, κυψέλη, *kupselē*, a chest), the characteristic fruit of the great order *Compositæ*, is one-chambered and one-seeded. It differs from a caryopsis mainly in being inferior and from an achene also in being syncarpous. It is often surmounted by a pappus, as in thistles and dandelions (*see* p. 39, and Fig. 61, p. 253). Like most one-seeded fruits it is indehiscent. The fact of its origin from two carpels may be gathered from its development and from the bifurcation of the style in the flower stage.

The *nut* is a closely similar fruit, formed of two carpels in the *Corylaceæ* or hazel tribe, and of three in the *Cupuliferæ* or oak tribe, and having commonly only one seed or "kernel" developed out of from two to six ovules. It differs mainly from the cypsela in the texture of the pericarp, which is tough, leathery, and but slightly lignified in the oak, chestnut, and beech, but decidedly woody in the hazel. It is indehiscent and is surmounted by at least a point as remnant of the perianth, this being more distinctly visible in the chestnut. The nut is commonly surrounded at the base by the more or less cup-like involucre or cupule that gives their name to the *Cupuliferæ* (*see* Vol. III., p. 308).

The *cremocarp* (Greek κρεμάω, *kremao*, I hang up), or inferior schizocarp, is most characteristically represented by the bicarpellary fruit of the *Umbelliferæ*. In this fruit each carpel contains one suspended seed. The fruit is generally furnished externally with more or less prominent ridges, varying in number, and between these there are often long cavities, or *vittæ*, in the pericarp filled with essential oils. When ripe it generally splits into two halves known as *mericarps* or *cocci*, each consisting of a carpel, which remain suspended to the prolongation of the axis or *carpophore* between the carpels (*see* p. 38, and Fig. 61, p. 253), from which fact the fruit derives its name. Th

carpophore often bifurcates. The so-called "Caraway seed" is one mericarp of *Carum Carui*; the "Coriander seed," a whole cremocarp which does not readily split up into mericarps. The mericarps themselves are always indehiscent.

The *berry*, like the capsule and the nuculane, is a type of fruit that has originated independently in many widely different natural orders. Differing only from the nuculane in being inferior, its characteristic is the succulence of the whole pericarp. The fruits of the gooseberry and other species of the genus *Ribes*, the banana and the *Cactaceæ*, such as the prickly pear, may be referred to this type. In the first-named we have the withered remains of the calyx on top of the fruit, and it should be noticed that a great portion of the pulp in this fruit forms part of the seeds and not of the pericarp.

The *pepo* (Greek πέπων, *pĕpōn*, a melon), the fruit of the order *Cucurbitaceæ*; differs from the berry mainly in the hardness acquired by its outer layers in the ripe state. Many fruits of this order contain powerful medicinal principles, such as colocynth and elaterium, and others, such as cucumber and vegetable marrow, are only edible in the unripe state. The pepo consists generally of three carpels, and most of the fleshy part in the cucumber is of receptacular origin, the fibro-vascular bundles of the carpellary leaves being distinctly visible near the ovarian cavity. The placental margins of the carpels run inward, but diverge without meeting in the centre, so that the placentation is parietal. In the genus *Luffa* the fruit is split and the cellular tissue rotted away, the remaining fibro-vascular skeleton of the pericarp and placenta being used, under the name "louphar," as a bath-glove.

Fig. 63.—A, Seedling of Linden (*Tilia*): *k*, cotyledons; *g*, plumule; *st*, hypocotyledonary axis; *w*, radicle. B, Germinating Oat: *a*, hypocotyledonary axis; *b*, primary root; *c*, cotyledon; *d*, first true leaf. C, Flower of White Dead-nettle (*Lamium album*). D, The same in Longitudinal Section: *g*, style; *fr*, ovary. E, Flowering Branch of the Plant. F, Gynæceum: *g*, style; *fr*, four cocci; *h*, honey-glands. G, Calyx. H, Front aspect of Flower. I, Stamen. K, Seed of Bean: *a*, radicle; *b*, cotyledons; *c*, plumule.

The *pome*, characteristic of the sub-order *Pomaceæ*

of the order *Rosaceæ*, consists of from two to five carpels, which in the flower stage are distinct and superior but subsequently become surrounded by, and imbedded in, the firm succulent receptacular tube. The carpels then form the "core" of the fruit, the divisions of which in the medlar, and even in the apple, remain fairly separate, though the withered calyx is carried up to the top of the fruit, so that we can hardly avoid calling it an inferior fruit.

In one variety of the hawthorn (*Cratægus Oxyacantha*, var. *monogyna*) as there is but one carpel, as seen by the single persistent style projecting between the dry sepals, the fruit is not strictly syncarpous, though inferior and therefore not a drupe. The core varies in texture from dense stoniness, as in this genus, in the medlar (*Mespilus*) and the quince (*Cydonia*), to a parchment-like character, as in apples and pears (*Pyrus*), and the flesh or so-called "mesocarp" of the hawthorn is more mealy than is that of most of the group. The pear (*Pyrus communis*) when wild, has scattered groups of sclerenchymatous cells in it which render it gritty; and it is further distinguished from the apple (*P. Malus*) by the large proportion of fleshy peduncle below the core, giving it its characteristic "turbinate" form and the concomitant absence of the *umbilicus*, or depression, in which, in the apple, the peduncle is inserted. There are generally only one or two seeds in each carpel.

Infruitescences.

In addition to true fruits and to those others, of which we have just been speaking, which (other structures as well as the gynæceum being involved in them) are more or less pseudocarps, there are several cases in which the term "fruit" is popularly applied to widely different structures. These cases result from a more or less complete fusion of the fruits or pseudocarps resulting from a whole inflorescence, and may, therefore, be termed *infruitescences*. The fig, the mulberry, and the pine-apple are three of the most interesting types of infruitescence. In the fig the peduncle, after giving off some bracts which might deceive the tyro into thinking them the calyx below a superior fruit, ceases, like the pedicel of a rose, to elongate at its apex, but continues to grow peripherally, thus giving rise, as in the rose, to a hollow obovate fleshy receptacle (Fig. 56). Whilst in the rose the fleshy receptacular tube is produced by a pedicel and bears only the sepals, petals, stamens, and carpels of a single flower, in the fig the similar structure is the common receptacle of a whole inflorescence. Round the mouth of the hollow other bracts are produced which again might mislead one into thinking it an inferior fruit; but the whole interior is lined with numerous monœcious flowers, each having a three-leaved perianth. The staminate flowers, each with three stamens, are nearer the mouth of the hollow urn; the pistillate ones, below. The true fruit is the little round one-seeded capsule or "pip," familiar in the dried figs of the Levant; but in this country the flowers, which require insect agency, seldom "set seed." Changes take place in the receptacle similar to those that occur in ripening fruits, the acids giving place to sugar and the chlorophyll being partly replaced by a purple pigment. In the allied genus *Dorstenia* the receptacle spreads out into a quadrangular plate with slightly inrolled edges.

The mulberry, though belonging to the same order as the fig, differs widely in the nature of its infruitescence. The staminate and pistillate flowers are in distinct spikes, and have each four perianth-leaves. In the female these perianth-leaves become succulent and sweet, enclosing the capsular fruit and turning from green, through red, to a purple-black. The succulent perianths of all the flowers in a spike come by their enlargement into close contact and form one mulberry. The term "berry" is thus popularly applied in the cases of the strawberry, raspberry, gooseberry, and mulberry, for instance, to four entirely different structures—to an etærio of achenes with a fleshy disk, to an etærio of drupels, to a succulent, inferior, syncarpous fruit, and to an infruitescence.

In the pine-apple (*Bromelia Ananas*) the inflorescence is a bracteate spike, the flowering branch terminating in a tuft of foliage-leaves. The flowers each have a superior six-leaved perianth and each gynæceum forms a three-chambered berry, which under cultivation is seedless. The peduncle, bracts, perianths, and berries all become one fleshy mass with a copious aromatic, sweet, but acidulous juice, the external rind bearing the membranous points of the bracts.

THE SEED.

We have already traced the changes in the interior and in the coats of the ovule which follow fertilisation. After fertilisation the ovule may be termed a *seed*; but not until after these changes are complete does it become a ripe seed. When ripe the seed is capable of remaining for a considerable time unchanged, this period of rest ranging from a few months up to many years. It is the one marked period of rest in plant-life.

Seeds vary very much in size, form, and character of surface. In any one group there is commonly a connection between the size of the seed and that of the full-grown plant; but it must be remembered

that the size of the seed in different species depends not only upon that of the embryos which they contain, but also upon the presence or absence, complete or partial, of a food-store, for their use during germination, in the shape of endosperm or perisperm.

The *testa*, or outer coat of the seed, may be smooth, as in the bean or the horse-chestnut, where it is marked by a large scar or *hilum* at its point of attachment; or may bear wrinkles, or ridges, in lines or in network, or tubercles, wings, or hairs. The seeds of spurrey (*Spergularia*) and toad-flax (*Linaria*) have a wing-like flange all round them, and those of the firs have a wing at one end. Cotton consists of the long unicellular hairs on the testa of *Gossypium*; in the willow there is a similar tuft of hairs, or *coma*, as it is called, springing from the funicle; in the willow-herbs (*Epilobium*) it springs from the chalaza; and in *Asclepias* from the micropyle. These wings and tufts of hairs on seeds, which only occur in dehiscent fruits, serve the same purpose as do those on the outside of fruits, viz., the dispersal of the seed beyond the shadow of the parent.

The testa is usually thick, leathery, opaque, impermeable, bitter, and indigestible, and is more often brown than any other colour. It serves to protect the contained embryo from premature germination by excluding damp, and may protect it from the action of sea-water or even of the digestive juices of the animal stomach. In the numerous rudimentary and rapidly germinating seeds of orchids, the testa, the only coat of the seed, is only one layer of transparent cells. Where, as in the stone-fruits and in the walnut, there is a thick woody endocarp the testa may not be very thick; but the Brazil-nut is exceptional in having a thick woody testa to its many seeds within a still more massive pericarp, with a tegmen within as thick as the testa of most seeds. The testa in the flax (linseed) is mucilaginous, swelling up when moistened; while that in the gooseberry and pomegranate is pulpy. Some seeds are, as we have seen, more or less completely covered by fleshy outgrowths known as *arils*. These may originate from the funicle, as in *Castalia*; from the raphe, as in *Chelidonium*, and in *Viola tricolor*; or from the edges of the micropyle, as in *Euonymus*, *Ricinus*, etc. The pink cup that grows up round the naked terminal seed of the yew (*see* coloured plate opposite p. 153, Vol. III.) may be regarded as a funicular aril. When present, the *tegmen*, *endopleura*, or inner coat of the seed, is usually delicate and cream-coloured, as in the almond, hazel, or walnut.

The body of the seed within these coats consists of the *embryo* alone in exalbuminous seeds; or, in albuminous ones, of the embryo and the *albumen*. In a few seeds, such as those of the almond and orange, two or more embryos are formed and may even germinate. The similar occurrence of two seedlings from a single acorn is due, however, to two seeds being developed in the one fruit. The embryo in Dicotyledons consists of two *cotyledons* which lie with their free extremities towards the chalaza; the *radicle*, which points towards the micropyle; and the *plumule*, or primary shoot, which lies between the cotyledons. (*See* Fig. 63, A, K.) In Monocotyledons, as their name indicates, there is but one cotyledon. In the parasitic genus *Cuscuta*, which belongs to the dicotyledonous order *Convolvulaceæ*, and in which the full-grown plant has no foliage-leaves, the embryo has no cotyledons, consisting only of an axis coiled round the albumen. In the oak three cotyledons are not uncommonly developed. In *Pinus* the two cotyledons are so deeply lobed as to appear like a whorl of many cotyledons, so that the whole class *Gymnospermia* were once termed *Polycotyledones*. In these plants, moreover, chlorophyll is, contrary to the general rule, developed in the cotyledons before germination. In most seeds the cotyledons are thick and fleshy, serving as storehouses of food for the seedling, and this is especially the case in those exalbuminous seeds in which they remain within the seed during germination. The parenchyma of the cotyledons may be oily, as in walnut and almond, or mealy, as in the bean. Veins may be distinctly traceable in them, as in the barberry and the linden; they may have petioles; they may be of unequal size; and are often very different in form from the foliage-leaves of the species. The cotyledons are variously folded on themselves and variously placed with reference to the radicle. For instance, the cotyledons may lie flat with the radicle resting against their edges, when the embryo is termed *pleurorhizal* (Greek πλευρά, *plĕura*, the side), the cotyledons *accumbent*, and the radicle *lateral*; or the radicle may rest upon the back of one cotyledon, when the embryo is *notorhizal* (Greek νῶτον, *nōtŏn*, the back), the cotyledons *incumbent*, and the radicle *dorsal*. Or, with a dorsal radicle, the cotyledons may be conduplicate, so as to embrace it, when the embryo is termed *orthoplocic* (Greek πλόκιος, *plŏkiŏs*, entwined); or they may be spirally coiled. These characters are employed to subdivide the large order *Cruciferæ* into tribes.

In the embryo of grasses the cotyledon forms a large shield, or *scutellum* (Fig. 63, B, *c*), in close contact with the albumen, upon which it feeds like a parasite, and only the plumule rises above ground in germination, whilst the radicle does not elongate,

but lateral rootlets burst their way through the lower part of the embryo, each surrounded by a torn ring of tissue or *coleorhiza*. Palms are exceptional among monocotyledons in developing a tap-root during the first few years of their lives.

In the seeds of gymnosperms, in those of almost all monocotyledons, except orchids and a few aquatic groups, and in those of many orders of dicotyledons, there is, in addition to the embryo, a nutritive tissue, the *albumen*. This, as we have seen, may originate from two sources, the tissue of the tercine, external to the embryo-sac, or perisperm, and the endosperm or tissue developed within the embryo-sac. In gymnosperms this latter tissue is formed before fertilisation, and may be termed the *archisperm* or *female prothallus*, corresponding probably with the antipodal cells in angiosperms. In angiosperms, being formed by the division of the secondary nucleus of the embryo-sac after fertilisation, the endosperm has been termed *metasperm*. In the peppers (*Piper*) and white water-lilies (*Castalia*) the seed contains both metasperm and perisperm separated by the embryo-sac; but usually one or other tissue has been absorbed. It may be stated generally that the albumen is largest when the embryo is smallest, and *vice versâ*. The albumen varies in texture, being either *farinaceous*, or mainly made up of starch-grains, as in grasses, buckwheat, etc.; *oily*, as in the poppy; *horny*, as in coffee; or *ivory-like*, as in the vegetable ivory (*Phytelephas*). In albuminous seeds the embryo may be *axile*, as in the pansy, or in *Cyperaceæ*, where it lies along the central axis of the seed with the albumen all round it; *peripheric*, as in *Lychnis* and other *Caryophyllaceæ*, where it surrounds the albumen; or *lateral*, as in grasses. In nutmeg, the areca-nut, and to a slight extent in the ivy, the inner coats of the seed form folds projecting inwards into the albumen, resembling folds found in the stomach of ruminant mammals, and the albumen is consequently called *ruminate*. This produces the mottled appearance of a nutmeg or areca-nut when cut across. Seeds in which no nutritive tissue external to the embryo exists in the ripe stage are termed *exalbuminous*. Besides *Orchidaceæ* among monocotyledons, the important orders *Cruciferæ*, *Guttiferæ*, *Geraniaceæ*, *Auranti-aceæ*, *Sapindaceæ*, *Leguminosæ*, *Rosaceæ*, *Myrtaceæ*, *Compositæ*, and *Cupuliferæ* among dicotyledons, are exalbuminous.

Seeds will often germinate although unripe, though in that condition they cannot be kept long without rotting. Cultivators make use of unripe seed to obtain early or double-flowered varieties. The seeds of mangroves and some other tropical trees may even germinate whilst still in the fruit hanging on the parent tree. Oily seeds are the most perishable. When in impermeable clay, or otherwise free from moisture, seeds will often preserve their germinating power for a long time; but there is no truth in the stories of the sprouting of wheat or other seeds taken from mummies. The requisites for germination are warmth, moisture, and oxygen. The degree of heat required varies with the species between 5° and 40° Cent.

The first sign of germination is commonly the swelling of the seed from the imbibition of a large quantity of water. In dicotyledons and palms this is generally followed by the protrusion of the radicle through the micropyle, this orifice thus serving a double purpose, admitting the entrance of the pollen-tube into the ovule and the exit of the radicle from the seed. Its position can be readily detected in a bean near one end of the hilum or scar of attachment if we soak the bean in water and then gently squeeze it between a finger and thumb, a jet of water issuing from the micropyle. In palms, though, unlike grasses, there is a protrusion of the radicle, the cotyledon remains, as in that order, within the seed, only its sheathing petiolar portion being pushed out, and from this sheath the *plumule* or primary shoot rises above the ground. In some dicotyledons, such as the bean (*Faba vulgaris*) and the acorn, which have exalbuminous seeds with thick fleshy cotyledons, the cotyledons similarly remain within the seed during germination, acting merely as food-stores, and the lower leaves on the plumule are the first to rise above ground, become green, and manufacture food for themselves from the carbon dioxide of the air and the liquid supplied them from the roots. When cotyledons thus remain under ground the germination is called *hypogeal*. In *Cruciferæ*, on the other hand, such as cress or cabbage, we have small exalbuminous seeds in which there can hardly be said to be any store of reserve food, so that it is important that the cotyledons should speedily commence manufacturing food for the seedling. Accordingly in these plants no sooner is the radicle pushed out than the thin cotyledons rise up, throwing off the now useless testa, and at once become green and form the first foliage-leaves. In the albuminous seeds of the castor-oil plant (*Ricinus*) and other dicotyledons, and among gymnosperms such as the Scotch fir, the cotyledons often remain within the seed for some time until all the albumen has been absorbed by them and conveyed into the seedling, but then rise above ground as green leaves. This form of germination is termed *epigeal*.

Within the seed during germination the starch or other carbo-hydrate reserve passes under the

influence of heat, moisture, and probably a nitrogenous ferment or *zymase* known as *diastase*, into the soluble form, mostly as malt-sugar (*see* Vol. II., p. 378). In the germination of the date and other palms it has been observed, and it is probably not very exceptional, that the cellulose thickening of some of the cell-walls of the endosperm becomes thinner, showing cellulose to be a reserve carbohydrate as well as starch. Aleurone, where present, also probably becomes soluble, so as to be readily transferable. During these rapid chemical changes a considerable quantity of oxygen is taken in from the air, the respiration of the plant being then more active than at any other period, except perhaps during the development of the flower-buds, and a sensible amount of heat is liberated. Carbon dioxide also is given off. All these processes are well seen in the artificially stimulated process of germination known as malting. In this manufacture the starchy seeds of cereal grasses are moistened and warmed till they send out rootlets; and when practice teaches the maltster that the maximum amount of carbo-hydrate has passed into, and remains as, sugar, further growth and its consequent changes, such as the building up of new cell-walls of cellulose from some of the sugar, are checked by raising the temperature beyond the limit of vital action and by breaking off the rootlets by sifting.

ENGLISH.—XXIII.

[*Continued from p. 248.*]

PHONETICS.

N.B.—It is useless to read the following unless the reader pronounces aloud the words and sounds given in the different experiments.

YOU have hitherto only studied words as component parts of a sentence. You must now learn something of the physiological processes by which sounds are produced by the organs of speech. This branch of science, which, as you will presently know, has an important bearing on philology, is called phonetics.

The object of phonetics, or the science of spoken sounds, is the analysis and classification of the numerous sounds which are employed in human language. Phonetics does not attempt to define the sensation of sound, for that, like all other personal sensations, is incapable of definition. Nor does phonetics occupy itself with the general theory of the production and transmission of sound. It accepts instead the teachings of other sciences—namely, that sound is always due to vibration; that the vibration, however created, is communicated to the surrounding air; that the air will transmit the vibration for a considerable distance; and that if a human ear comes within that distance the drum of the ear takes up the vibration and conveys it by means of the auditory nerve to the brain. So far all is clear and demonstrable, but why the vibration of the drum of the ear should produce in the brain the familiar sensation of sound we do not and cannot know. We simply accept the fact that it does so, and say that the sensation of sound is caused by the vibration of the drum of the ear, which in turn is caused by the vibration of the air. When, therefore, we experience different sound-sensations, it is clear that these differences must be due to differences in the air-vibrations. How, then, are these differences in the air-vibrations produced? This is exactly the question which phonetics tries to solve, so far as human speech is concerned. In other words, when a listener hears first the sound *see*, let us say, and then the sound *go*, the phonetician ought to be able to tell us what the speaker has done to make the difference.

But before attempting to find out how differences in speech-sounds are produced we must obviously know something of the means by which speech is formed at all. The study of phonetics must begin with a study of the organs of speech, and their methods of working. As far as possible in conducting this study we will appeal only to facts which each learner can verify for himself by his own experience, and then it is to be hoped he will be willing to accept with more readiness the few facts that we shall be obliged to state on the authority of persons who have been able to examine the interior anatomy of the human body. (*See* Vol. II., p. 209.)

First, then, we ask the reader to notice that whenever he speaks breath is expelled from his mouth. This elementary fact he can verify by the simple expedient of holding his hand at a short distance in front of his mouth while he is speaking. What does this mean? It means first that breath is a necessary element in the formation of speech sounds. But it means more than this. For if we bear in mind what was stated above, that sound is due to vibration, and if we notice, as we shall have occasion to do presently, that in the case of most speech-sounds, all we do is to place the parts of the mouth in the proper position, and then allow the breath to escape, we shall see that the passage of breath is not only a necessary accompaniment of the sound, but is itself the cause of the sound. In other words speech-sounds are formed by the vibration of the breath as it passes through the complicated passage that leads from the lungs to the outer air. As breath, then, is the foundation of speech, we ought perhaps to begin our study with a description of the mechanism by which the

breath is expelled from the lungs. But it would needlessly complicate our subject to do this with any detail. It is sufficient to say that there are certain muscles in the chest which have the power to compress and to dilate the lungs, and thus make them act very much like a pair of bellows. In ordinary breathing this process goes on automatically, the lungs being expanded to draw in the fresh air from outside, and contracted to expel the same in an altered condition after it has done its work of purifying the blood. But in speaking, a conscious effort is necessary in order to apply additional compression to the lungs and compel them to drive out the breath more forcibly. It is this forcibly expelled breath which is the foundation of all speech.

Now let us trace the breath as it leaves the lungs, and see what opportunities it has of being modified in its passage outwards. Immediately on leaving the lungs, the breath is conducted by a multitude of tiny conduits, called bronchial tubes, into the trachea or windpipe, a large elastic tube that passes up the front of the throat. At its upper end this tube expands into rather a wider passage or chamber called the larynx, an organ which makes itself visible by the protuberance on the throat known as Adam's apple.

Within the larynx are two elastic ligaments, like a piece of drum parchment slit in the middle, forming an aperture between them which is called the *glottis*. The two parchment-like ligaments are called the "vocal chords," and play a most important part in the production of speech sounds. The glottis, or the slit-like aperture between the vocal chords, is in adults normally about four-fifths of an inch long and one-twelfth of an inch broad. It is provided, however, with muscles by which it can be widened or narrowed within moderate limits at pleasure. In the same way the vocal chords can be lengthened or shortened, tightened or relaxed in various degrees by the muscles they contain.

Most of the above statements with regard to the larynx and the important organs it contains must be taken on trust by the student; but he can verify for himself the existence of the vocal chords by placing his finger on his throat, immediately above Adam's apple, and holding it firmly there while he speaks aloud. He will then be able to feel distinctly with his finger the vibration of the vocal chords within the larynx.

Passing onwards along the route which the breath follows on its way from the lungs to the outer air, we come, above the glottis, to another somewhat similar opening, which constitutes the orifice or mouth of the larynx. This opening is called the exterior or false glottis, and like the real glottis can be narrowed or partially closed at will. Just above it is fixed a sort of valve called the epiglottis, which can be pressed down upon the exterior glottis, thus closing the orifice of the larynx. These two organs, the exterior glottis and the epiglottis, do not often come into play in the actual formation of speech sounds, but they perform a very important function in the human economy. Their importance can best be realised by people who try to speak while in the act of swallowing. Everyone knows the result of this experiment, but the cause of the choking that ensues is less well known. It is this: when we speak we must expel breath from the lungs through the windpipe and the larynx; therefore, the orifice of the larynx must be left open. But if so, there is nothing to prevent food or drink, on its way from the mouth to the gullet, making a mistake and slipping into the larynx. The function of the valve-like epiglottis then is to close down upon the exterior glottis or the mouth of the larynx, that solids or liquids may pass safely over it on their way to the gullet. The epiglottis may therefore be described as the door of the larynx; the exterior glottis is the door*way*; and the true glottis is an open grill or portcullis a little distance inside the passage.

We have now done with the windpipe and the larynx for the present, and can pass onwards. Between the epiglottis, or the gate of the larynx, and the mouth there is no distinct organ, but the open cavity or bag at the back of the mouth and above the larynx is sometimes specially designated as the "pharynx." We shall not, however, have occasion to refer to it often, and pass on to the mouth proper.

The roof of the mouth consists of two parts, a soft and a hard palate. The former is at the back of the mouth and is sometimes called the *velum pendulum*. Attached to it is a soft hanging piece of muscular tissue known as the *uvula*. The function of the uvula is to close, when required, the passage from the mouth to the nostrils. In its normal condition it hangs loosely downwards, and the breath then passes out freely both by way of the mouth and by way of the nostrils. But in speaking, the uvula is, for the most part, pressed backwards so as to close the passage to the nostrils. The whole of the breath must then come out by way of the mouth. As we shall see presently, however, there are certain speech-sounds which are formed by allowing the uvula to hang loosely so that part of the breath may pass outwards through the nostrils.

About the hard palate we need not say anything by way of description, for it is sufficiently familiar to everyone. The palate is of very great importance in the differentiation of speech sounds, for a large

number of different sounds can be produced by merely altering the position of the tongue with regard to the palate.

The tongue again is an organ which does not need description. It is, perhaps, of all the organs of speech the most important. By its wonderful flexibility it is able to modify the current of breath in an infinitude of ways as it leaves the mouth, and thus produces the most subtle variations of sound. So important indeed is the part played by the tongue in the formation of speech, that it has often been regarded as *the* organ of speech. Thus the very word language means originally something derived from the tongue, for *lingua* is the Latin name for tongue. Again, the French constantly use the word *langue* or tongue for language, while our own literature is full of instances where *tongue* is used in the sense of language. In a scientific account of human speech, however, it is necessary to recognise that the tongue is only one among the many organs which contribute to the production of the wonderful variety of sounds which the mouth can emit.

Besides the tongue and palate, the teeth and lips also play an important part in the formation of sounds. Certain sounds are produced by pressing the tongue close up against the teeth, and the sounds will vary according to the part of the teeth which is touched by the tongue. The lips may either act alone in modifying the current of breath that leaves the mouth, thus altering the sound given forth; or they may work in conjunction with the teeth, thus producing another set of sounds.

Finally, we must not overlook the work done by the cheeks. By drawing in the cheeks we can give roundness to the cavity of the mouth, and thus modify very considerably the sounds produced.

We have now described with sufficient detail the various organs by means of which human beings produce speech. Our next task is to see in what ways these organs do their work, or rather to bring together a description of the way in which the organs work, with a description or classification of the results, *i.e.*, the sounds produced. In other words we have now to point out what particular sounds are the results of what particular configurations of the organs of speech. We have, in fact, to classify the sounds according to the methods by which they are produced. This is, indeed, if we reflect upon it, the only possible method of classifying speech-sounds, for it would be hopeless to attempt any classification based upon the indefinable sensations produced on the brain of the hearer.

In proceeding, then, to classify sounds according to their source, our best plan will be to follow the course of the breath as it leaves the lungs, and notify each cause of differentiation of sound as we meet it. As was explained above, the breath, which is the primary source of all speech-sound, passes from the lungs by way of the bronchial tubes into the windpipe and thus into the larynx. Within the larynx it encounters its first obstacle, namely, the vocal chords. These, it will be remembered, we compared to two strips of drum skin separated by a tiny slit. The vocal chords, by means of the muscles they contain, can be tightened or relaxed, and similarly the slit, or glottis, can be opened wide or almost entirely closed. Thus through the agency of the vocal chords and the glottis the passage of the breath through the larynx can be facilitated or checked at will. From this circumstance we get the first great division of all speech sounds into "voiceless" and "voiced." When the glottis is left open the breath flows through silently, and any sound it may give rise to is due to subsequent modifications. On the other hand when the glottis is closed the breath, in forcing its way past the vocal chords, causes these little drum skins to vibrate, and thus creates a distinct sound to which the name "voice" is given.

Let us test this. The consonant *f*, phoneticians say, is a "voiceless" consonant, *v* is a "voiced" consonant. To verify this statement, bite the under-lip with the edge of the upper teeth, then breathe out through the mouth. The consonant *f* will be produced. Keeping the lips and teeth in exactly the same position, now try and produce *v* without adding a vowel to it. You will at once set up a rumbling noise in the larynx, and if you place your finger on Adam's apple you will be able to feel the vibration of the vocal chords. Again, make the sound represented by *s*, and then, without altering the position of tongue and teeth, tighten the vocal chords, and the sound represented by *z* in *zebra* will be produced. The same thing may be done with the two distinct sounds of *th*, which occur respectively in the words *thin* and *then*, and with the pair of sounds, of which one is represented by *sh* in *shall*, and the other of which might be represented by *zh* in the place of *s* in *pleasure*. When these experiments have been successfully performed, the same processes may be applied to the pairs of consonants *p* and *b*, *t* and *d*, *ch* and *j*, *k* and *g* (hard).

We have now established a very clear and very important distinction between two classes of sounds, voiced and voiceless. This distinction is often recognised under other names. Thus, *p*, *t*, *k* are sometimes called "sharp" consonants, and *b*, *d*, *g* "flat" consonants; or sometimes the contrasted words "thin" and "thick" are used or "light" and "heavy." But these names are unsatisfactory, because they rest upon the assumption that the sounds in question impress each person in exactly

the same way, whereas this is not the case, and few people would agree as to the relative thickness or weightiness or flatness of *p* and *b*. On the other hand everyone can test by his own personal experience, by placing his finger on his throat in the manner described above, that whatever difference there is between the sounds of *p* and *b* that difference is marked by the vibration in the latter case, and not in the former, of the vocal chords. Therefore, the most scientific and the most suitable name for the two classes of sounds, represented by *p* and *b* respectively, is "voiceless" and "voiced."

Before passing on to the next division of sounds, we will presently give a list of the principal voiced and voiceless sounds in the English language. It is first, however, necessary to say a few words about a method of speech which, though common enough to be perfectly familiar to everybody, is yet distinct from the speech of ordinary conversation, we mean whisper. When we whisper what is it we do that distinguishes the sounds produced from those of ordinary loud speech? The student shall answer this question for himself. Let him pronounce aloud in his ordinary tone the sound represented by *a* in the word *father*. As he does this let him place his finger on his throat as in the experiments described above. He will distinctly feel the vocal chords vibrate. The sound *a* is therefore a "voiced" sound. So also is the sound *o* in *go*, or the sound *u* in *rule*, or *i* in *machine*, or *a* in *fate*, and we shall later on specify numbers of other sounds of the same nature which are also "voiced." Now let the student pronounce the same *a* in *father* in a whisper; the whisper may be as loud as he likes, but it must be a whisper. If he again places his finger on his throat he will at once feel that the vocal chords are silent. He may do the same thing with all the other sounds just enumerated, and he will obtain the same result.

Here, then, we get an explanation of whisper; it is "voiceless" speech. But wait a minute. We said above that the distinction between *p* and *b* was that one was "voiceless" and the other "voiced." But if *all* whisper is "voiceless" how can we maintain the distinction between *p* and *b* when we whisper them? And yet we do maintain the distinction when whispering almost as easily as when speaking aloud, and a man must whisper very badly who induced his hearer to confuse *feel* with *veal*. In order to arrive at the explanation of this apparent contradiction, let us go back to our old experiment with *f* and *v*; only this time it must be all done in a whisper. Place the lower lip against the edges of the upper teeth, and then force breath through. The sound represented by *f* will be produced. Now, taking care not to allow the vocal chords to vibrate, *i.e.*, not to speak aloud, try and turn your *f* into a *v*. You can discover whether you have actually got to a whispered *v* by going on to whisper the word *villain* or any other word beginning with *v* that occurs to you. When you are quite sure that you have got a whispered *v*, go back again to *f* and then pass repeatedly from *f* to *v*. You will very soon notice a distinct sensation inside the throat when you pronounce the whispered *v*. This sensation is due to the narrowing of the glottis. It will be remembered that it is by closing the glottis in ordinary loud speech, so that the breath in forcing its way through makes the vocal chords vibrate, that we produce the distinction between loud *f* and loud *v*. In whispering we try to do the same thing. Having pronounced *f* in the ordinary way, we begin to close the glottis for *v*, but at the last moment we reflect that complete closure will give rise to "voice" and spoil our whisper. We therefore merely narrow the glottis just enough to mark a distinction between *f* and *v*.

Thus, to make our analysis complete, we ought to enumerate *three* states of the glottis: open as for the *f* of loud speech, or for whispered *a*; narrowed as for whispered *v*; and closed as for loud *a* or loud *v*. This fuller statement reconciles completely the apparent contradiction mentioned above. Whisper, we see, is always "voiceless"; so also are consonants like *p, t, k, f, s*. On the other hand *b, d, g, v, z* are necessarily "voiced" in ordinary conversation, and in whisper they are distinguished from *p, t, k*, &c., by a narrowing of the glottis, which, if continued long enough, would produce voice. It will be noticed that there is thus no distinction between the *f* of loud speech, and the *f* of whisper, and on this ground it has sometimes been proposed that *p, t, f*, &c., should be called "whispered" consonants, and *b, d, v, z* "spoken" consonants. But as we have just seen, it is possible to whisper *b, d, v*, and; therefore, it is better to keep the word "whisper" for use in its ordinary popular sense. We shall, therefore continue throughout to use the terms "voiced" and "voiceless" in the same sense as hitherto; but it must be remembered that when the "voiced" consonants *b, d*, &c., are whispered, the glottis is only partially closed, so that audible "voice" is not produced.

A PRELIMINARY LIST OF SOUNDS.

At length we are in a position to make a list of the principal sounds used in the English language, classifying them according as they are "voiced" or "voiceless." For the sake of brevity, in drawing up our list, we will make use in advance, as we have already done once or twice, of the terms vowel and consonant, asking the reader to give them their

ordinary meanings until we have time to explain scientifically the distinction between the two sets of sounds.

The voiceless sounds then are:—

(*a*) The following consonants, *p*, *t*, *k*, *ch*, *s*, *sh*, *th* (in *thin*), *f*, and *wh*.

(*b*) All vowels when spoken in a whisper.

The voiced sounds are:—

(*a*) The following consonants, *b*, *d*, *g*, *j*, *z*, *zh*, *th* (in *then*), *v*, and *w*; also *m*, *n*, *ng*, *r*, *l*, and *y*.

(*b*) All vowels when spoken aloud.

The student should not accept this classification without verifying its accuracy for himself. He should take each voiceless consonant and ascertain by actual experiment that by merely adding "voice" to it, *i.e.*, allowing the vocal chords to vibrate, he can reproduce the corresponding familiar voiced consonant. He should also test himself in every possible way to see that he fully grasps the difference between mere breath and "voice."

One useful experiment that helps to make this important difference clear is the following:—Place the lips and teeth in position to pronounce *f*, and then, as in previous experiments, expel the breath through the closed passage so as to produce the consonant *f* without any vowel. While doing this, gently part the teeth and lips, the breath will then escape noiselessly into the air, or with only such slight explosive noise as is caused by the sudden outrush. Now repeat the same process with *v*. When the lips are parted a distinct noise—which we might represent in writing by *ur* or *er*—will be heard, in addition to the slight puff that occurs with *f*, and this noise is "voice."

A SCALE OF CONSONANTS.

By the way of exercise to the vocal organs, and his powers of perception, the student should run up and down what we may call the scale of the consonants. That is to say, he should say rapidly after one another all the voiceless consonants *p*, *t*, *k*, etc., and then all the voiced consonants, *b*, *d*, *g*, etc. He should also combine the two together, passing from *p* to *b*, *t* to *d*, and so on. In doing this, he must, of course, be careful to pronounce *only* the consonant, not adding any vowel sound. This is easy enough in the case of consonants like *f*, *v*; *s*, *z*; *sh*, *zh*; and the two sounds of *th*; but some difficulty will be found at first with *p*, *b*; *t*, *d*; *ch*, *j*; *k*, *g*. With a little care and practice, however, the difficulty can be readily surmounted.

When the student by these means has acquired a thorough mastery of the distinction between voiced and voiceless sounds, in cases where both sounds are familiar to him he should next try if he can produce an unfamiliar voiceless sound from his knowledge of its voiced counterpart. Let us take as a first experiment the consonant *wh* in the word *when*. In the south of England this word is generally pronounced in identically the same way as the word *wen*, a mole. Thus, so far as southern Englishmen are concerned *wh* may be classed as an unfamiliar consonant. How are we to produce it? First of all we must ascertain carefully that we can pronounce the consonant *w* without a vowel following it. To do this pronounce aloud several times, *woo*, *woe*, *wee*, and in each case try gradually to eliminate the vowel altogether. After a time the student will find that he is able to produce with his lips the explosive sound of the pure consonant *w*. He will then notice that this sound is accompanied with that vibration of the vocal chords which we have called "voice." We have thus ascertained that *w* is a voiced consonant. If now the student is quite sure that he can say *w* without a following vowel, let him now try to "unvoice" his *w*, that is, pronounce it with an open glottis so that the vocal chords do not vibrate, he will then produce the true *wh* as it is pronounced by correct speakers of English in the north of England and Ireland.

There are two more experiments of the same kind that may with advantage be tried. As in the case of *w*, let the student pronounce the consonant *l* without a succeeding vowel. He will find that *l* is formed by allowing the tongue to vibrate against the roof of the mouth, and that it is a "voiced" consonant. Now "unvoice" it. If the experiment has been done accurately, the sound produced will be the voiceless *lh*, that occurs so frequently in the Welsh language, and is there represented by *ll*.

THE GERMAN ICH.

The student who has read the lesson on the pronunciation of German will have noticed that it is difficult for an Englishman to pronounce the sound represented by *ch* in the German *ich*. But when the following experiment has been performed several times, the pronunciation of *ch* should be rendered quite easy.

Let the student then take the consonant *y* as in the words *you*, *yea*, *ye*, etc., and learn to pronounce it without a vowel following. He will find that it is a voiced consonant formed by the tongue approaching the palate. If he is able to unvoice it, without altering its character, he will get the German *ch* in the word *ich*. This experiment is a little more troublesome than the previous ones, because while the English *y* always occurs initially as in *you*, the German *ch* always occurs finally as in *ich*. It is necessary, too, to be careful not to confuse the sound in *ich* with that in *ach*, which is a distinct sound, although represented by the same symbol.

BOOK-KEEPING.—XV

[Continued from p. 238.]

TRIAL BALANCE.

THE student will have thoroughly understood that in a complete system of book-keeping there must be, arithmetically, a debit for every credit and a credit for every debit, and that consequently the debit and credit postings in the Ledger must, if added separately, yield equal totals. The last fact is made use of periodically to check the accuracy with which the Ledger has been entered. A list is made of all accounts open during the period, giving for each, in addition to the folio (or page) of the Ledger, and, possibly, the name, the total amount posted to the debit side of the account in a column of debits and the total amount posted to the credit side of the account in a column of credits. The grand total of the debit column should agree with the grand total of the credit column, and each should be equal to the total of the journal columns to the same date. If such agreements are not found to exist, there is a mistake in the work, which has to be sought out and set right. The process now described by which we try whether the ledger postings are in equilibrium or, as it is called, "in balance," is a process known in book-keeping as drawing out a *Trial Balance.* We give a few lines of the Trial Balance for the

31 JANUARY, 1898.

	Debit postings. £	s.	d.	Credit postings. £	s.	d.
1. Stone - - - - -	50	0	0	2,500	0	0
2. Wood - - - - -	50	0	0	2,500	0	0
3. Cash - - - - -	3,513	6	6	1,407	18	11
... ...	......			......		
40. Interest - - - - -	38	7	6	10	19	7
43. Sundry Expenses - -	5	2	0	—	—	
Totals, agreeing with Journal	13,469	13	0	13,469	13	0

At the end of February a Trial Balance may be prepared for the two months, at the end of March for the three months, and so on to the end of the half-year or other period when the Ledger is closed and all outstanding balances brought down, and the book-keeping receives a fresh start.

When two or more accounts are placed on the same folio (or page) of the Ledger, the Trial Balance is sometimes prepared in a contracted shape by recording the total debit and credit postings for each folio instead of for the accounts individually.

Another form of Trial Balance statement consists in taking out the balances of the accounts instead of the full debit and credit postings. This procedure results in a simpler-looking statement, and one the details of which are ever so much more intelligible, but it sacrifices the grand total mentioned above, and its agreement with the Journal total to the same date. If, therefore, in posting into the Ledger, a complete entry in the Journal were omitted, the omission, being one of equal debit and credit, would not be discovered. But no one of the arrangements for trying the balance is perfect; they all fail to detect the misplacement of an item posted to the wrong account. The only way of preventing an error of this kind is to go over all the postings a second time. Each figure may be neatly ticked in pencil as it is found to be correct. We give a specimen, abbreviated as before, of the "balance" form of the Trial Balance Statement:—

31 JANUARY, 1898.

	Debit Bals. £	s.	d.	Credit Bals. £	s.	d.
1. Stone - - - - -				2,450	0	0
2. Wood - - - - -				2,450	0	0
3. Cash - - - - -	2,105	7	7			
... .	....			....		
40. Interest - - - - -	27	7	11			
43. Sundry Expenses - - -	5	2	0			
	7,443	5	5	7,443	5	5

This form of Statement is especially suitable when the Ledger balances carried forward from the close of one period to the beginning of the next are not journalised, as is sometimes the practice.

We may now conveniently explain a few of the Minor Books in Book-keeping.

PETTY CASH BOOK.

The small payments constantly arising in business, and representing the incidental expenses of the business, are usually met out of a sum of money expressly set aside for the purpose, and known as Petty Cash. These payments, as a rule, are so small as not to justify their entry in the ordinary books of the business except in the compressed form of daily, weekly, or monthly totals. Accordingly it has become the practice to enter the advance for petty cash purposes in the Cash Book on the day the sum is set aside, and periodically to journalise the total amount expended. In some offices the advance is not recorded in the Cash Book at all, and then the process is to enter the expenditure at intervals in the Cash Book (not the Journal) as the total is ascertained. Small receipts may be brought to account in the Petty Cash Book, but this course is not very usual. Whenever the book is closed the expenditure and receipts, if any, must be summarised under the various heads of account opened in the Ledger, but this under ordinary circumstances is an extremely simple matter, as the items affect little else than the Trade or Sundry Expenses Account. The following illustrates a form of the book in question:—

PETTY CASH.

		£	s.	d.			£	s.	d.
1898.					1898.				
Jan. 7.	Advance	20	0	0	Jan. 7.	Postage Stamps	1	10	0
					„ „	Receipt Stamps	1	0	0
					„ 10.	Porterage		5	0
					„ 12.	Train and Bus (V. Docks)		1	6
					„ 17.	Ditto		1	6
					„ 22.	Packing-cases	2	1	0
						Journalised	5	2	0
					„ 31.	Bal. to next month	14	15	0
		20	0	0			20	0	0
1898. Feb. 1	Bal. from last month	14	15	0					

WAREHOUSE BOOK.

In many of the warehouses of wholesale merchants and, to some extent, in the sale shops and workshops of smaller traders a register, of a more or less formal and permanent character, is kept in which are recorded, in ledger fashion, for each species of goods, the quantities incoming and outgoing to and from the business. Incoming goods are recorded on the debtor or receipt side of an account for the particular goods, and outgoing goods on the creditor or issue side. We give two specimens of Warehouse Book, the first illustrating the principle of a separate account for each kind (Pekoe) of a certain class of goods (Tea), and the second a collective account for a whole class of goods, the different kinds of the class being shown in the detail columns.

PEKOE TEA.

1898.	(*Received from*)	Chests.	lb.	1898.	(*Issued to*)	Chests.	lb.
Jan. 9	Wormell & Co.	10	665	Jan. 17	Thos. Canton	1	66
May 2	ditto	5	333	Mar. 5	ditto	1	66
				June 30	On hand	13	866
		15	998			15	998
July 1	On hand	13	866				

The duty on the above tea not having been paid when it was purchased of Wormell and Co., the tea remained "in bond," *i.e.*, impledged for payment of the duty, and was retained in a warehouse over which the Government had control. Under such circumstances the marks on the chests, by which the packages are identified, may very conveniently be inserted in the second or descriptive column on each side of the account. A set of money columns both for the debit and credit portions of the account may be introduced to allow of the insertion of the respective buying and selling values of the goods bought and sold, but only under exceptional conditions could such columns serve any really useful purpose.

It will be observed that an account of Goods is opened in the Warehouse Book although these goods may be stored at the Docks or other place elsewhere than on the business premises.

GOODS ON COMMISSION

(*Stephen White, Newcastle*).

	(*Received from*)	Sewing Machs.	Washg. Machs.	Lawn Mowers		(*Issued to*)	Sewing Machs.	Washg. Machs.	Lawn Mowers.
Jan. 22	S. White	12	6	6	Jan. 29	James Ball	3	1	–
Mch. 15	ditto	–	12	12	„ 31	Alfred Hawkes	–	2	–
Apr. 18	ditto	6	–	6	Feb. 22	James Ball	3	–	3
					„ 27	Alfred Hawkes	1	2	2
					June 21	James Ball	–	1	8
					„ 28	Dumas & Fils	–	5	–
					„ 30	Goods on hand	11	7	16
		18	18	24			18	18	24
July 1	Goods on hand	11	7	16					

INVENTORY OR STOCK BOOK.

Whenever the books are closed, it is necessary to make out a detailed list of the goods remaining on hand. If for every parcel of goods sold it were easy to allocate the selling price exactly between cost and profit, the former being credited to the particular goods account and the latter to the account of Profit and Loss, and if the Goods remaining unsold never shrank in quantity or depreciated in value, we could keep the Goods account in the Ledger up to the level of theoretical perfection; but this idea is practically unattainable, and we have no resource but that of a periodical stock-taking.

A detailed list of the stock on hand having been made out, each item is usually priced according to its cost, an abatement, however, being made in all cases where, from damage or in consequence of a change in fashion, the goods could be bought at the time of taking stock for less.

We subjoin a specimen of the Inventory or Stock Book entries.

STOCK ON HAND ON THE 30TH JUNE, 1898.
DRAPERY GOODS.

			£	s.	d.
42 pieces Sarsenet, 1,050 yards - @		1/6	78	15	–
130 ,, Longcloth, 6,455 ,, -		/6	161	7	6
90 ,, Flannel, 5,740 ,, -		$1/0\frac{1}{2}$	298	19	2
195 ,, Linen 2,340 ,, -		1/4	156	–	–
80 ,, Calico 4,120 ,, -		$/6\frac{1}{4}$	107	5	10
35 black Llama Shawls - -		$4/0\frac{1}{2}$	7	1	5
100 black Cashmere ,, - -		11/2	55	16	8
45 black Embroid. ,, - -		38/1	85	13	9
120 wool Clouds - - - -		2/–	12	–	–
80 Shetland Falls - - - -		$2/4\frac{1}{2}$	9	10	–
Total carried to Journal, p.		£	972	9	4

.... *(Here would follow details of the stock of Tea, Leather Goods, and Tobacco)*..

GOODS ON COMMISSION
(The property of Stephen White, Newcastle).

		£	s.	d.
11 Sewing Machines Invoiced @	3/3/–			
7 Washing Machines - -	10/10/–			
16 Lawn Mowers - - -	3/5/–			

In the case of Goods received for sale on Commission, and which, as in our case, remain the property of the sender, it is not necessary to fill in the money columns.

ACCOUNT CURRENT BOOK.

An Account Current, or running account, is a statement in detail of the various transactions taking place between two parties acting one for the other. It is generally the account rendered by a District Manager or an Agent to his Principal, or by a Consignee to his Consignor. An Account Current is usually prepared in the form of an ordinary account with debit and credit columns, and sometimes interest is computed on all the items, whether of receipt or payment, and the final balance increased or diminished thereby. If any item, *e.g.*, a bill of exchange, is not payable till a subsequent date to that on which it is received and entered in the Account Current, interest runs from the day of its becoming payable, and if this last date should fall beyond the period of account, interest for the subsequent interval is entered on the opposite side of the account by way of discount. In some cases a Commission is chargeable to the Account Current.

The following is a simple illustration supposed to be taken from an Account Current Book.

NATHAN HERSCHELL, Esq., BARBADOES, IN ACCOUNT CURRENT WITH STONE & WOOD, LONDON.

Date.		Amount. £	s.	d.	Days to 31 Dec.	Interest Prodcts.	Date.		Amount. £	s.	d.	Days to 31 Dec.	Interest Products.
1898. Sept. 23	To Cash paid for Freight -	23	15	4	99	2,376	1898. June 30	By Balance - - -	1,370	5	–	184	252,080
,, 25	,, do. paid for Duties -	107	8	7	97	10,379	Nov. 8	,, Cash recd. for Sugar	231	–	–	53	12,402
Oct. 1	,, do. paid for Dock Dues	5	19	6	91	546	Dec. 31	,, Interest due to you -	26	14	1		264,482
Nov. 4	,, do. paid for Bills - -	700	–	–	57	39,900							69,549
,, 8	,, do. paid for Brokerage	2	6	9	58	106		Net sum of products =					194,933
Dec. 4	,, do. paid for Bills - -	600	–	–	27	16,200						$\frac{1}{3}$ =	64,977
												$\frac{1}{10}$ =	6,497
												$\frac{1}{10}$ =	649
,, 24	,, do. paid for Insurance	5	15	6	7	42		Sum, divided by 10,000 =					26|7,056
,, 31	,, Balance due to you - -	185	13	5		69,549						= £	26 14 1
		1,630	19	1					1,630	19	1		

In the above illustration the interest is calculated at 5 per cent.; from this the amount of the interest at any other rate is readily deduced. In forming the products the amounts are taken to the nearest pound: thus, £23 15s. 4d. is taken as £24, £107 8s. 7d. as £107, and so on. To the net sum of the debit and credit products is added one-third, a tenth of the third, and a tenth of the tenth, and from the total so produced are cut off the last four figures, giving the interest required in pounds and decimals of a pound. In offices where "Interest Books" are at hand, the interest on each item may be inserted at once instead of using the preliminary product of pounds and days.

ACCOUNT SALES BOOK.

An Account Sales is a statement of the receipts and payments in connection with the sale of goods by an Agent for his Principal. It shows the quantities sold, the prices at which sold, the various charges attendant on the sale, and the net proceeds. Copies of such accounts may be kept in a book specially set apart for the purpose and known as the Account Sales Book. The following is an example of one form of Account Sales: but the form in use is subject to variation, the statement being frequently arranged in debit and credit portions, the charges and net proceeds falling on the debit side and the proceeds on the credit side. Journal entries are sometimes made direct from the Account Sales Book.

Account Sales of Five Hogsheads Tobacco, per s.s. "John Bull," from New York, and sold by STONE & WOOD, *London, by order and for account of — — Henderson, Kentucky, @ two months prompt.*

			Cwt. qrs. lb.			
1898. Jan. 1.	By ◇A.B.◇	1	10 0 0			
		2	11 1 0			
		3	11 0 1			
		4	12 0 1			
		5	12 1 0			
			56 2 2 = 6330 − 127 (2%) = 6203 @ 1/- per lb.			£310 3 0
	To Charges.					
	Entry Rent (6/-), Porterage of Samples (6d.), Fire Insurance, etc.			2 3 0		
	Extra Rent			1 8 0		
	Extra Fire Insurance			0 10 6		
	Dock Charges and Import Rate			1 14 3		
	Incidentals			0 1 6	5 17 3	
1897. Nov. 1.	Freight			3 15 0		
	Primage 3' (loading charge)			0 3 9		
	Advance Charges			4 14 11		
	Insured from New York to London @ £40 each is £200 @ 20/-			2 0 0	10 13 8	
					16 10 11	
	Interest on above Charges from 1/11/97 to 3/3/98—122 days, @ 5% per ann.				0 5 6	
	Commission, Delcredere (to Stone & Wood for guaranteeing payment by the purchaser), etc., on £310 3s.				5 0 0	21 16 5
	Net proceeds, 3rd March, 1898					£288 6 7

E & O E (meaning errors and omissions excepted). London, Jan. 2nd, 1898.

(Signed) STONE & WOOD.

GEOMETRICAL PERSPECTIVE.—VIII.

[Continued from p. 244.]

PROBLEMS—XL.—XLIII.

PROBLEM XL. (Fig. 65).—*A box 6 feet long, 3 feet wide, and 1 foot 6 inches high, inclined to the picture at an angle of 37°. The lid is open and thrown back at an angle of 45° with the perpendicular. Thickness of wood, 2 inches. Depth of lid, 6 inches. Distance of the eye from the picture plane, 6 feet, and its height from the ground 2 feet 6 inches. The nearest angle to touch the picture plane. Scale, $\frac{3}{8}$ inch to the foot.*

If the lid is at an angle of 45° with the perpendicular, it will be at the same angle with the horizon; therefore, as VP² is the VP for the end of the box, the angle of inclination must be made from DVP². To cut off the retiring length of the lid, the line of contact must be drawn from *c n* to *b*, and then from DVP³ draw a line through the corner of the box joining the lid to *a*; make *a b* equal to the width of the box, and rule from *b* back again to the DVP³. For the depth of the lid draw from DVP⁴ to *n* on the line of contact; make *n c* equal to the depth 6 inches, and draw back again as before. As the other parts of the construction are the same which have been repeatedly explained in previous problems, we leave the remainder as an exercise for practice.

In Problem XXXIX., page 243, it was stated that the door at the side was at an angle of 40° with the wall upon which it hung, and that the wall was perpendicular with the PP. The rule for finding the VP in this particular case was explained. We

wish now to say more upon this part of the subject. It very frequently happens that the angle of the given line or object is stated as being at an angle with *another plane*, or with *another object either parallel or at a right angle with the* PP. For example, the wall of a building may retire at an angle of 30° with the PP, and some other projection may extend from it at a given angle with this wall, which it can do either from a horizontal or a perpendi-

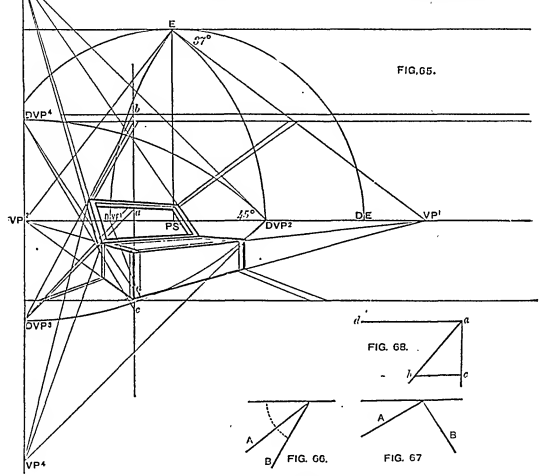


FIG. 65.

FIG. 66.

FIG. 67

FIG. 68.

cular connection. We must then know how to determine its angle with the PP. It is true it is not always necessary to know the angle of the PP *for the sake of executing the drawing*, as the given angle can be in some cases constructed upon the vanishing line of the plane with which the projection is connected instead of the PP; but we cannot pass over this way of stating the question, as many have imagined a difficulty without any substantial reason for doing so. It may be necessary *to know the angle the projection makes with our position* for reasons altogether independent of the drawing; it may be to answer the inquiry of an employer; or the draughtsman, knowing how the parts of a building *are placed with each other*, may wish to satisfy himself as to the appearance the whole will have when viewed from some particular point. But what is of more immediate importance to us now is, that it opens out a new way to explain the difficulties that arise sometimes from a confusion in the mind respecting the treatment of vanishing lines, vanishing planes, and vanishing points, all these being so closely combined in the principles and practice of construction. Thus, by considering them under every possible connection, we become more familiar with them, and they are more readily comprehended in their details, however numerous they may be, and also when united together as a whole.

1st. Suppose a retiring wall A forms an angle of 30° with the PP, and there is a projection from this wall at a right angle with A, the projection will then be at an angle of 60° with the PP, or with our position.

2nd. Suppose a retiring wall at an angle of 30° forms an angle of 120° with a projecting wall, the

projecting wall will also be at an angle of 30° with our position in the opposite direction.

3rd. Suppose the retiring wall at an angle of 30° with the PP forms an angle of 30° with the projecting wall, the latter will be at an angle of 60° with the PP. (*See* Fig. 66.) We do not say at an angle of 120°, because we always prefer to make use of the angle formed by the nearest approach of the projection to the line of our position, or the picture plane.

4th. Again, suppose an inclined shutter, or a roof which is united horizontally with a wall, is said to be at an angle of 40° with the wall, the shutter or roof would be an angle of 50° with the ground.

All this will be very evident if we consider that "*if any number of straight lines meet in a point in another straight line on one side of it, the sum of the angles which they make with this straight line, and with each other, is equal to two right angles.*" Therefore (Fig. 67), if A is 30° with the PP, and B 90° with A, then B will be 60° with the PP, the whole making two right angles. With regard to the last *supposition*, we shall see that the lines of the wall, the roof or shutter, and the ground, form a right-angled triangle, the three interior angles of which are together equal to two right angles. Therefore, as the angle of the wall with the ground is 90°, and the shutter or roof 40° with the wall, the shutter will be at an angle of 50° with the horizon (Fig. 68). Consequently, this angle of 50° must be constructed for the vanishing line, and the subject treated as an inclined plane. (*See* Problems XXXI., XXXII., and XXXIII.) From all this we deduce a rule for finding vanishing points for lines or planes which are stated to be at given angles with other lines or planes not parallel with the picture plane.—*When the sum of the two angles of the given objects is greater than a right angle, it is subtracted from the sum of two right angles, and the remainder is the extent of the angle sought.* This will explain the results of the first, second, and fourth *suppositions* above.

When two angles of the given objects are together less than a right angle, the sum will be the angle sought. This answers to the third supposition. We now propose a problem to illustrate our remarks about the wall and the shutter.

PROBLEM XLI. (Fig. 69).—*A wall at an angle of 40° with our position is pierced by a window of 4 feet 3 inches high and 4 feet broad; a shutter projects from the top of the window at an angle of 40° with the wall; the window is 5 feet from the ground, and its nearest corner is 5 feet within the picture; other conditions at pleasure. Scale of feet* $\frac{1}{48}$.

Before proceeding to work this problem, we wish to give the student some directions about the scale. In this case we have given the *representative fraction* of the scale, and not the number of feet to the inch. It is a common practice with architects and engineers to name the proportion of the scale upon which the drawing is made, in the manner we have done here, leaving the scale to be constructed if necessary. The meaning of the fraction $\frac{1}{48}$ is that *unity* is divided into the number of equal parts expressed by the denominator. Thus a scale of feet $\frac{1}{48}$ signifies that one standard foot is divided into 48 equal parts, each part representing a foot on paper, the result is $\frac{1}{4}$ inch to the foot. It also means that the original object, whether a building or piece of machinery, is 48 times larger than the drawing which represents it. If the scale had been written, yards $\frac{1}{48}$, it would be the same as $\frac{3}{4}$ inch to represent a yard. The way to arrive at this is as follows:—

inches.

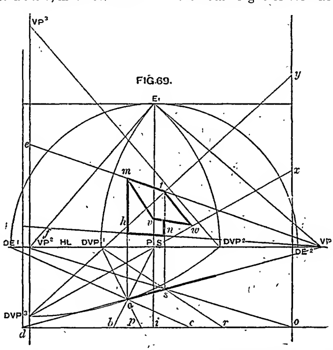
$\frac{1}{48}$ of $\frac{12}{1} = \frac{1}{4}$ inch to the foot.

$\frac{1}{48}$ of $\frac{36}{1} = \frac{3}{4}$ inch to the yard.

The above method of stating the scale ought to be understood by everyone engaged upon plan-drawing.

To return to the problem. The principal consideration relates to the shutter. The inclination may be upwards, at an angle of 40° with the wall, or it may be downwards at the same angle. We will represent both cases. First, when inclined downwards. Draw the HL, which is 4 feet from the ground line; from PS draw a perpendicular to E; this will be the radius for drawing the semicircle meeting the HL to determine DE^1 and DE^2. Find the vanishing point for the wall VP^1, and its distance point DVP^1; also find the VP^2 by drawing a line from E to VP^2 at a right angle with the one from E to VP^1, because if the shutter had projected from the wall in a horizontal position, it would have vanished at VP^2; that is, if it had been perpendicular or at right angles with the wall. In short, the vanishing point for the horizontal position of a line must always be found whether the line retires to it horizontally or not, because the VP for an inclined retiring line is always over or under the VP (according to the angle of inclination) to which it would have retired if in a horizontal position. (*See* Problem XXXI., Fig. 53.) Consequently, the vanishing point for an inclined retiring line is found by drawing a line from, in this case, the DVP^2, according to the angle of inclination, to where it cuts a perpendicular line drawn through the VP^2; thus we find its vanishing point, whether its inclination be downwards or upwards; therefore draw a line from DVP^2, at an angle of 50° with

the HL, cutting the perpendicular from VP^2 at VP^3, the vanishing point. We have made the nearest corner of the window 2 feet to the left of the eye, represented by the distance *i* to *b*; a line from *i* must be ruled to PS, upon which we wish to cut off 4 feet to find *a*, the nearest point within; a line from *c*, which is 4 feet from *b*, must be drawn to DE^1, and where it cuts the line *b* PS in *a* is the point required. Draw the perpendicular *a h m*. Draw from DVP^1 through *a* to *p*; make *p r* equal to the width of the window. Draw back again from *r*, cutting DVP^1 in *s*; draw the perpendicular *s t*; the base of the window is drawn from *f*, on the line of contact, 5 feet from the ground, to the VP^1; the height of the window, 4 feet 3 inches, is marked from *f* to *e*; a line from *e* to VP^1, cutting the perpendiculars from *a* and *s* in *m* and *t*, will give the top of the window. The opening of the window is *m t h n*. Now we must draw the shutter; the corner nearest us is *v*, consequently it *inclines upwards towards the wall, but downwards from it*; therefore the VP for the shutter must be above the HL, which we have explained. To measure or set off the length of the shutter, we have raised *a line of contact* for that purpose from *o*, found by drawing from VP^2 through *s* to meet the ground line. From *t* directed from VP^3 draw a line through *w*; this will be the further side of the shutter; its length must be determined thus :—From *t* directed from DVP^3 draw a line to the line of contact, meeting it in *y*; make *y x* equal to the length of the shutter, the same as the length of the window; draw from *x* back again to DVP^3, cutting *t w* in *w*; draw *w v*, directed by VP^1, and *v m* directed by VP^3.



We will now draw the shutter at the same angle with the wall, but inclined upwards from it (Fig. 70). The important difference in working the problem under these conditions arises from the upward inclination of the shutter *from* the wall, *but inclined downwards to meet the wall.* This last view of the position of the shutter is the proper one for our purpose, because after a little consideration we shall perceive that it is a *retiring plane*, but *downwards*; therefore its VP is below the eye or HL. (In the former case the shutter was a retiring plane, but upwards, establishing its VP *above* the eye or HL.) Consequently, we must draw the vanishing line for the VP^3 downwards from DVP^2. The sides of the shutter, *t w* and *m v*, must be drawn in the direction of VP^3, and cut off from DVP^3, first by drawing a line through *t* to *y*; make *y x* equal to the length of the shutter; draw from *x* to DVP^3, producing *w*. All the early part of the problem, relating to the wall and windows, and the remaining lines *w v* and *t m*, will be but a repetition of the shutter under the first position. We can prove the truth of this method of drawing the perspective inclination of a plane by another method. Draw the right angle *c a d* (Fig. 68); make *a b* equal to the length of the shutter, and at an angle of 40° with *a c* or 50° with *a d*; draw *b c* parallel to *a d*; *a c* will be equal to the height of *b* above *a*. This must now be applied to Fig. 70. Draw a line from VP^2 through *t* to *e* on the line of contact; make *e f* equal to the height of *b* above *a*, viz., *c a* (Fig. 68). Draw from *f* back to VP^2; it will be found to cut the corner of the shutter in *w*, proving by both methods that *t w* is the perspective length of the further side of the shutter.

A plan of a building may be made, having all its proportions, angles, and other measurements arranged and noted, yet nothing may be said as to its position with the picture plane, and from this plan several perspective elevations may be raised. When such is the case, all that is necessary will be to draw a PP across the paper in such a position with the plan, that by drawing visual rays the picture plane we have chosen may receive the view we wish to take of it. Suppose A (Fig. 71) is the plan of a building, and we wish to have two views of it—one taken with an end and front in sight, the other with a view of the front and the opposite side—we

should then place the PP at such an angle with the side or front as might be considered to be the best for our purpose. PP[1] would receive the visual rays from the front and the end B; PP[2] would receive those from the front and the end C. In short, any line may be drawn which represents the PP at any angle with the plan, or opposite any side we may wish to project. This will give a very useful illustration of the way to treat a subject when its proportions are given, as is frequently the case, without any reference to the view to be taken of it; in other words, the angle it forms with the picture plane.

PROBLEM XLII. (Fig. 72).—*A folding screen of four leaves,* A. B. C. D. *Two of the leaves,* A *and* B. *form an angle of* 100°; C *is at an angle of* 80° *with* B; *and* D *at an angle of* 70° *with* C. *The screen is* 6 *feet high, and each leaf is* 3 *feet broad. Height of the eye,* 5 *feet; and distance from the pictureplane,* 9 *feet. The eye opposite the centre of the leaf* B.

In drawing the ground plan, make the plans of the leaves A. B. C, D each 3 feet long, and unite them according to the angles stated in the question. The PP may be drawn at any distance from it, and in any position the draughtsman may consider to be most convenient, with reference to any particular view of the subject he wishes to represent, bearing in mind that the *direction of sight from the selected station point of view must be perpendicular to the* PP. Therefore the line drawn from the centre of the leaf B (opposite to which the eye is directed according to the conditions in the question) must be drawn perpendicularly to the PP; and upon it place the SP 9 feet from the PP. The HL and base of the picture may be drawn anywhere below the PP. From the SP draw vanishing lines to the PP, to produce the vanishing points; and mark each VP with the letter of the leaf to which it belongs, to ensure the right direction of the extremities of each leaf respectively. Draw visual rays from each angle of the plan to the PP, in the direction of the SP, afterwards to be drawn perpendicularly from the PP. Produce the plan of one of the leaves, say A, to the PP, for a point of contact; *ef* will then be the line of contact upon which to mark the height of the screen *fh*.

FIG. 70.

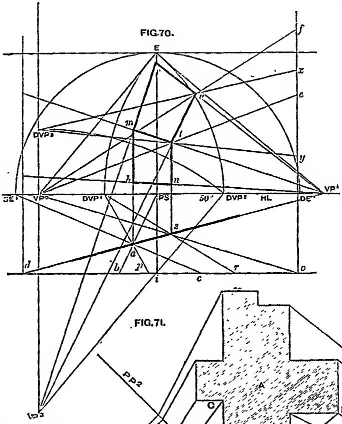
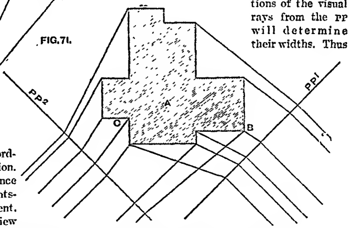


FIG. 71.



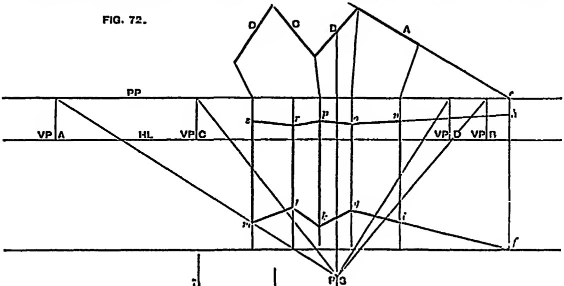
We must remind our pupils here that they are *to follow the course of the ground plan* when drawing the perspective, positions of the ends of the leaves, viz., the tops and bases; change the directions at the visual rays, and be guided by their respective vanishing points; whilst the perpendicular continuations of the visual rays from the PP will determine their widths. Thus *inog* represents the leaf A; *ophg* the leaf B, *prlh* the leaf C; and *rlms* the leaf D.

PROBLEM XLIII. (Fig. 73).—*A flight of eight descending steps. Length of steps,* 12 *feet; width of each,* 1 *foot* 2 *inches; depth of each,* 6 *inches. Height of eye,* 7 *feet. Distance of the eye from the* PP, 9 *feet. Scale,* ¼ *inch to the foot.*

Draw the horizontal line, and the plane of the picture 7 feet below it. Place the PS and DE[1] and

DE² at 9 feet from PS. The first thing to be considered is the inclination of the steps, found by constructing a profile or section of them from DE¹. Make the distance from DE¹ to *a* equal to the width of the steps, 1 foot 2 inches; also the spaces *a b*, *b c*, and *c d*, the same. Draw perpendiculars from each of these points to *e*, *f*, *g*, and *h*; making *a e* equal to 6 inches; *b f* twice that distance; *c g* three times; and *d h* four times. Rule a line from DE¹, through the points *e*, *f*, *g*, *h*, to the VP on the perpendicular line drawn through PS. This last line, *e f g h*, will represent the downward inclination of the steps. The tread of each step may be drawn through the points *e*, *f*, *g*, *h*, parallel to the HL. From VP, with the radius to DE¹ draw the arc from DE¹ to DVP, for the distance point of the vanishing point of the inclination. Set off the length of the first step, *i k*, equal to 12 feet. Draw a perpendicular line through *i* for a line of contact or measuring line. Draw from *i* and *k* to VP. Upon these last lines will be found the angles of the steps, thus:—Set off from *i* upwards the spaces 1, 2, 3, 4, etc., each equal to the *inclined* spaces from DE¹ to *e*; from *e* to *f*; from *f* to *g*, etc. Rule from each of these points to DVP. Where these lines cut the one from *i* to VP will be found the angles of the

FIG. 72.



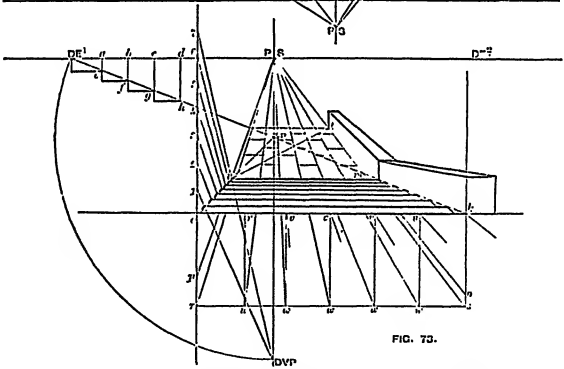


FIG. 73.

steps. The top of each step must be drawn from these intersections directed from PS, because the tops or treads of the steps are horizontal; and as they retire at right angles from the picture plane, they have the PS for their vanishing point. The other ends of the steps upon *k* must be treated in the same way. The balustrade at the right may be drawn at pleasure, observing that the top of the descending portion vanishes at VP; whilst the horizontal portion from the bottom vanishes at the PS. The points *m* and *n*, from which to draw the retiring edge of the pavement, are found thus:—Draw a perpendicular line from *k* downwards, continue the top of the lowest step at each end, directed from the PS, until the lines meet the perpendiculars in *p* and *o*; make *p r* and *o s* each equal to the depth of the step, 6 inches; rule back again from *p* and *s* to PS. These last lines, appearing beyond the edge of the lowest step, will be the perspective of the sides of the horizontal pavement. To draw the widths of the slabs which compose the pavement, first divide *i k* into the same number of parts as there are slabs to be represented in *v*, *v*, *v*, etc. From these points draw perpendicular lines to meet one drawn from *r* to *s* in *w*, *w*, *w*, etc. From each of these points *w* draw lines to PS. Where they appear beyond the line *m n* will be represented the retiring edges of the slabs. A diagonal line from *n* to *t* will enable us to find the parallel edges of the slabs, because their angles meet the retiring lines which represent the retiring edges, and the diagonal which cuts them.

PNEUMATICS.—II.

(Continued from p. 228.)

BOYLE'S LAW.

EXPERIMENT shows that a given quantity of gas may be made to occupy almost any volume, however small, by compressing it sufficiently. Gas is also remarkable for its tendency to expand freely of its own accord and fill any volume when its pressure is gradually diminished. Thus any quantity of gas taken as small as we please, and introduced into a closed vacuous vessel, however large, will exert some pressure against the sides of the containing vessel, always normal to the surface, and the gas will be found uniformly distributed throughout the space occupied. If the same weight of another gas be introduced into the same vessel, it will exert pressure on the sides independent of the gas already present in the vessel, provided the two gases do not act chemically upon one another. Hence the total pressure on any square inch of surface inside the vessel will be the sum of the pressures exerted on it by the two gases separately. In the same way if the size or internal volume of the vessel be kept the same, 2 lb. of gas will exert twice the amount of pressure exerted by 1 lb. of the same gas on the sides of the vessel, under the same conditions.

Again, the pressure of a given quantity of gas on the sides of the containing vessel will be found to increase as the temperature is raised or the volume diminished; so that we need to know the *pressure*, *volume*, and *temperature* of a given mass of gas at one time before we are in a position to investigate the changes in any of these afterwards.

Robert Boyle, born at Lismore, Ireland, 1626, published in 1662 his *Defence of the Doctrine touching the Spring and Weight of the Air.* In this book he describes the experiments by which he discovered and established the law connecting the volume and pressure of a gas kept at constant temperature.

Mariotte, a Frenchman, is said to have deduced the same law independently from similar experiments. However, the date of his treatise *De la Nature de l'Air* is given in the *Biographie Universelle* as 1676.

According to Boyle's Law:—

When the temperature remains constant, the volume of a given quantity of gas varies inversely as its pressure, that is, the product—

$$\textit{Pressure} \times \textit{Volume} = \textit{Constant},$$

where the pressure is taken above a perfect vacuum. Since the mass or quantity of stuff in the gas remains the same, this law clearly implies that the density of the gas increases as the volume is reduced.

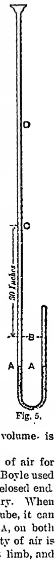


Fig. 5.

In order to investigate the elasticity of air for pressures greater than the atmospheric, Boyle used a long glass tube (Fig. 5) bent near the closed end. The tube must be quite clean and dry. When mercury is slowly poured into the long tube, it can be made to stand at the same level, A A, on both sides of the bend. In this way a quantity of air is enclosed above the mercury in the short limb, and the pressure is atmospheric since the mercury stands at the same level in both limbs. Suppose the tube perfectly uniform in bore, then the volume of the gas is directly proportional to the length of tube occupied.

Now double the pressure on the enclosed air by pouring mercury very slowly into the long tube until the difference of level between the tops of the mercury C and B in the two limbs of the tube is 30 inches, or equal to the height of the barometer. The compressed air in the short tube exerts a pressure equal to that of the height B C or 30 inches of mercury, together with the atmospheric pressure at C, that is, altogether two atmospheres or twice the original pressure. If the mercury has been poured in slowly, and the compressed air allowed to cool to its original temperature, the air will be found to occupy half the length of tube it filled at first. Thus doubling the pressure halves the volume.

When more mercury is poured in to make the difference of level in the limbs equal to twice the height of the barometer, so that the enclosed air is subjected to a total pressure of three atmospheres, and the air is allowed to cool to the same temperature as at starting, it will be found to occupy one-third the original volume. It is necessary to pour in the mercury *slowly*, otherwise the air will be raised in temperature when quickly compressed, and we must then wait to give it time to cool before reading the heights of the mercury columns.

Fig. 6.

We find that as the pressure is increased two, three, or four times, the volume of the air becomes one-half, one-third, or a quarter what it was at first.

Again, the apparatus (Fig. 6) may be used to determine the relation between the volume and pressure of air when it is allowed to *expand* at constant temperature for pressures less than atmospheric. Both limbs of the bent glass tube are more than barometer height, whilst the tap at the bottom is arranged to let the mercury run out of both tubes when desired. First have both limbs filled with mercury to the same level A, enclosing dry air in the short one at atmospheric pressure to start with as in the previous experiment.

Now open the stop-cock and let out mercury slowly until the air occupies double its original volume, when the mercury stands at B in the short limb. More mercury will have left the long limb because of the constant atmospheric pressure on its upper surface, which will therefore have fallen a greater distance than in the short limb, where the pressure driving out the mercury is much less. The difference of pressure on the ends of the mercury columns in the two limbs is found to be B C, equal to half the barometer height, that is, the pressure exerted by the enclosed air is half an atmosphere less than the pressure on the mercury at C. The pressure on C is simply atmospheric, hence the pressure of the air at B is half an atmosphere, whilst the volume occupied by the air has been doubled. The temperature must remain the same throughout the experiment, or in other words, the mercury must be allowed to run out so slowly that the air above B whilst being cooled by expansion may have time to gain heat from the tube and surrounding bodies to keep its temperature constant.

If more mercury is let out till the air occupies three times its original volume, the pressure exerted by it on the mercury will be one-third of an atmosphere, and so on. Thus the volume of a gas is found to increase in the same proportion that its pressure diminishes, or as before:

Absolute Pressure $\times$ *Volume* = *Constant.*

Instead of the bent tubes shown in Figs. 5 and 6, a short glass tube like A B (Fig. 5) connected to a longer tube A C D by a piece of stout india-rubber tubing will serve the double purpose of compression and expansion of the air enclosed in the tube A B by keeping this tube fixed and moving the other tube A C D up or down along a scale graduated to give the difference between the level of the top of the mercury column in each.

Regnault, Despretz, and others tested Boyle's law, with the result that it is not perfectly true for any actual gas; but that for all practical purposes the law is obeyed by air, and gases when highly rarefied and far above the critical temperatures at which they liquefy. On the other hand instead of the product, pressure $\times$ volume, remaining constant, it diminishes for such gases as carbonic acid and ammonia which readily liquefy, and the divergence increases as these gases are highly compressed near their points of liquefaction. Hydrogen gas is a remarkable exception, since for it the product: pressure $\times$ volume, instead of remaining constant as by the ideal gas law, actually increases with compression. There is a certain temperature at which hydrogen exactly obeys the law. In fact, at ordinary temperatures such gases as dry air and oxygen very nearly obey the law when highly rarefied; on the other hand compression at low temperatures, which tends to bring gas to the liquid state, produces further deviation from this behaviour of the perfect gas.

Boyle's law enables us, when once we know the volume and pressure of a quantity of gas, to find any one of these in future if we know the other,

and provided the temperature is the same in both cases.

For example, a perfect gas occupies 2 cubic feet at a pressure of 50 lb. per square inch; what is its volume v when the pressure is reduced to 20 lb. per square inch at the same temperature?

In this case the product, *pressure* × *volume*, becomes

$$50 \times 2 = 20 \times v,$$

therefore,
$$v = \frac{50 \times 2}{20},$$

that is,
$$v = 5 \text{ cubic feet.} \qquad \textit{Answer.}$$

Exercise 1.—The constant temperature of a perfect gas is 20° Cent. when its volume is 20 cubic centimetres, and pressure 760 millimetres; find its volume when the pressure is 152 millimetres.

Answer.—Volume = 100 cubic centimetres.

Exercise 2.—A perfect gas like dry air, occupying 2 cubic feet at atmospheric pressure, and 120° Cent., is compressed into 1·2 cubic feet, what pressure will it now exert on the sides of the containing vessel at the same temperature?

Answer.—24·55 lb. per square inch.

We have already observed that the volume occupied by a gas may be expressed in terms of length of tube if the tube be of perfectly uniform bore throughout. The same holds for the volume of working fluid contained in the cylinder of a pump or engine.

If the internal diameter of a cylinder of uniform bore be d inches as measured carefully by gauge, then the cross-sectional area of the piston working in this cylinder and fitting it exactly, is

$$\frac{\pi}{4} d^2 = \cdot 7854 d^2 = \text{A square inches (say).}$$

That is, the uniform sectional area of the cylinder is A square inches, or $\frac{A}{144}$ square feet.

The volume of gas contained in all the passages and ports equal to l feet length of this uniform cylinder, is

$$v = \frac{A\,l}{144} \text{ cubic feet;}$$

whilst distances moved through by the piston are expressed in feet.

Let the pressure of the gas behind the piston be p lb. per square inch measured from perfect vacuum.

We shall now have for the product in Boyle's law:—

$$p\,v = \text{a constant, } k,$$

by substituting above values

$$\frac{p\,A\,l}{144} = k,$$

so that

$$p\,l = k \div \frac{A}{144};$$

but the expression $\frac{A}{144}$ is always the same for any one cylinder of uniform section, so we may say Boyle's law becomes

$$P\,L = \textit{constant},$$

where p is the absolute pressure above vacuum, in lb. on every square inch of surface, and l is the length of uniform cylinder equal in volume to that of all the space in the ports, passages, and cylinder behind the piston occupied by the gas; in other words, l is the distance of the piston from end of this uniform cylinder. So long as the temperature remains the same, this formula enables us to calculate the change in pressure of a gas as the piston passes through a given distance, when we know the length of cylinder occupied, and the pressure of the gas at any time.

Suppose the piston is 1·5 feet from the end of the cylinder, when the pressure of the gas is 140 lb. per square inch, what is the pressure p of this gas at the same temperature when the piston is 2 feet from the end of the cylinder?

In this case the constant, equal to the product pl, is 140 × 1·5 at start, so that

$$140 \times 1 \cdot 5 = p \times 2,$$

therefore,

$$p = 105 \text{ lb. per square inch.} \qquad \textit{Answer.}$$

Exercise 3.—Dry air and gas compressed to 60 lb. per square inch in a pump cylinder of 12 inches internal diameter, when the piston is 1 foot from the end of cylinder, is admitted into a motor cylinder of 9 inches in diameter, what will be the pressure when the motor piston is 2 feet from end of cylinder at constant temperature?

Answer.—In this case where the compression and motor cylinders are of different internal diameter, it becomes necessary to calculate the volume occupied by the air in each separately.

What is the volume of the air in cubic feet?

The compression cylinder is 12 inches or 1 foot internal diameter, and its cross-sectional area is found by substituting the known numerical values for the symbols in the expression $\frac{\pi}{4} d^2$, which here becomes

$$\frac{3 \cdot 1416}{4} \times 1 = \cdot 7854 \text{ square feet.}$$

Hence the volume of one foot-length of this cylinder occupied by the air, namely, sectional area × length, is

$$\cdot 7854 \times 1 = \cdot 7854 \text{ cubic foot;}$$

when the pressure is 60 lb. per square inch.

Again, the motor cylinder is 9 inches or $\frac{3}{4}$ foot in internal diameter, and its sectional area is

$$\cdot 7854 \times d^2 = \cdot 7854 \times \left(\frac{3}{4}\right)^2$$
$$= \cdot 7854 \times \frac{9}{16}$$
$$= \cdot 4418 \text{ square foot.}$$

Hence the capacity of 2 feet-length of this cylinder,

or, $\cdot 4418 \times 2 = \cdot 8836$ cubic foot,

is the volume of the air at, say, pressure p lb. per square inch.

Since the temperature of the air is the same in both cases, we know that, according to Boyle's law, the product—pressure × volume—is constant; and this was $60 \times \cdot 7854$ in the compression pump, so that

we have $60 \times \cdot 7854 = p \times \cdot 8836$,

hence the required pressure,

$$p = \frac{60 \times \cdot 7854}{\cdot 8836},$$

or, final pressure, $= 53 \cdot 33$ lb. per square inch.

We must be careful to bear in mind that the two necessary conditions for a perfect gas obeying Boyle's law are: (1) That the temperature must be kept constant; and (2) the amount of gas under consideration must remain the same. Clearly, if we alter the quantity of gas occupying a given volume whilst the temperature remains the same, we thereby change the pressure.

Moreover, the same quantity of gas will evidently increase in pressure when heated and kept at constant volume.

We have already expressed Boyle's law: (1) In words; and (2) by the algebraic symbols, $p\,v =$ constant; we shall further represent it (3) by columns of figures; and (4) graphically by curves in order to be in a position to appreciate fully its bearing on many problems that engage the attention of the physicist and practical engineer.

Take 20 cubic feet of gas, at pressure 10 lb. per square inch, in a cylinder kept at constant temperature. This gas will occupy double the volume—*i.e.*, 40 cubic feet under half the pressure—*i.e.*, 5 lb. per square inch; and by changing the volume to 100 cubic feet, the pressure becomes 2 lb. per square inch.

Here $p\,v = 10 \times 20 = 5 \times 40 = 2 \times 100 = 200$.

In fact, by splitting up 200 into factors, we may find any number of corresponding values for p and v of this amount of gas while its temperature is kept constant. These values may be tabulated in columns thus:—

$$p\,v = 200.$$

Absolute Pressure, in lb. per Square Inch above Vacuum. p.	Volume, in Cubic Feet. v.
100	2
50	4
40	5
20	10
10	20
5	40
4	50

The law connecting the pressure and volume can be represented by a curve found by plotting or mapping out the above figures on a sheet of squared paper (Fig. 7).

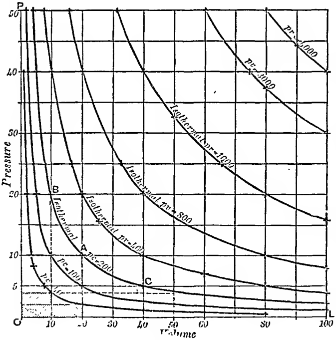


Fig. 7.

Vertical distances or heights above some fixed horizontal line, O L, will represent pressures, and horizontal distances measured from the vertical line O P will represent the corresponding volumes or lengths of cylinder occupied by the given quantity of gas. Select any convenient scales for pressure and volume so as to have all the values within the bounds of the sheet of squared paper. Now measure off along the horizontal 20 equal divisions to represent the volume 20 cubic feet, and lay off 10 divisions on the vertical scale for the corresponding pressure (Fig. 7). The perpendicular and horizontal lines through these points meet in the point A, which we mark by a little cross.

Laying off half the volume, *i.e.* 10 horizontal divisions, and double the pressure, *i.e.* 20 vertical divisions, gives the point B, which shows the volume and pressure at another time. Thus the point C (Fig. 7) shows that when the gas occupies 40

cubic feet it exerts a pressure of 5 lb. per square inch. When a great number of corresponding values are plotted in this way, we observe that all such points A, B, C, etc., lie along a regular curve which gradually approaches the lines O P and O L, but never actually touches them. This agrees with the experimental facts that we can never, by any pressure, however great, reduce the volume of a gas to zero, whilst by expansion in any ordinary cylinder or vessel we can never reduce the pressure to zero, when the temperature and mass of stuff are kept always the same.

Such a curve tells us at a glance the relation at any point between the values of p and v for the given mass when the temperature remains constant; and it is called an *isothermal* curve, from two Greek words meaning *equal temperature*. Moreover, since the condition, $p\,v =$ constant, holds true for all points along the curve, we know this curve is a rectangular hyperbola referred to the lines O P and O L as asymptotes. Thus the areas bounded by the two co-ordinates of any point along this curve and the asymptotes are all equal, being also expressed by the product $p\,v$ which, by Boyle's law, is constant.

Suppose we heat the same quantity of gas at the outset until its pressure is 40 lb. per square inch when it occupies 10 cubic feet of the cylinder at the new temperature. The product $p\,v$ is now 40×10, or 400. If we split this number into factors and plot all the corresponding factors as before, we get another similar isothermal curve which shows the relation between the pressure and volume of the same mass of gas at the new constant temperature.

We can therefore plot or map out a whole series or family of isothermals for the same quantity of gas by taking the corresponding pressure and volume at different temperatures. The family of isothermals mapped out in Fig. 7 represents the relations between pressure and volume of the same mass of gas at different constant temperatures. The same relations may be shown by the columns of figures:—

ISOTHERMALS.

$p\,v = 40$		$p\,v = 100$		$p\,v = 400$		$p\,v = 800$	
p	v	p	v	p	v	p	v
40	1	100	1	100	4	100	8
20	2	50	2	50	8	50	16
10	4	25	4	40	10	40	20
8	5	20	5	25	16	20	40
5	8	10	10	20	20	16	50
4	10	5	20	16	25	10	80
2	20	2·5	40	10	40	8	100
1	40	2	50	8	50		
0 5	80	1	100	4	100		

GERMAN.—XXIII.

[*Continued from p. 234.*]

IDIOMATIC PHRASES (*continued*).

Lei, Gehen.

TH– obsolete word lei (sort, kind) still remains in combination with the numerals, forming what are called the *variatives*. Thus, Einerlei, "of one kind," "the same;" Dreierlei, "of three kinds": as:—Dreierlei bringe ich zu dir, erwähle dir eines, three (sorts of) things I bring (to) thee, choose thee one; Es ist ihm einerlei (*or* eins), ob er geht, oder bleibt, it is the same to him whether he goes or stays.

Gehen, with the preposition über, is often used with the signification "to transcend," "to surpass," as:—Zufriedenheit geht über Reichthum, contentment surpasses wealth.

EXAMPLES.

Wie es dem Vogel nicht einerlei' ist, ob er sich in dem Kä'fige, oder in der freien Luft befin'det, so darf es einem Volke auch nicht eins sein, ob es in Sclaverei', oder in Freiheit ist.	As it is not the same to the bird whether it is (finds itself) in the cage or in the open air, so likewise can it not be the same to a nation whether it is in slavery or in freedom.
Dies geht mir über Alles.	This with me excels everything.
Dem Auf'richtigen geht nichts über die Wahrheit.	To the upright nothing is better than the truth.
Manchen Menschen geht nichts über Bequem'lichkeit und Ruhe.	With many persons, nothing goes beyond convenience and repose.
Wir gingen über Moskau nach Pe'tersburg.	We went by way of Moscow to Petersburg.
Der Feind ging bei Wien über die Donau.	The enemy went over the Danube at Vienna.
Es ist unrecht, die Zeit seines Lebens in Ab'geschiedenheit von den ü'brigen Menschen zuzubringen.	It is wrong to pass one's life in seclusion from the rest of mankind.

VOCABULARY.

Begün'stigen, to favour.
Bonn, *n.* Bonn.
Einerlei', of one kind, the same.
Erzie'hung, *f.* bringing up, education.
Ente, *f.* duck.
Entsa'gen, to renounce.
Fünkchen, *n.* sparklet.
Gang, *m.* direction, course.
Gedul'dig, patiently.
Gefühl', *n.* touch.
Geschäft', *n.* affair, business.
Gymna'sium, *n.* gymnasium, classical school.
Heilsam, beneficial.
Lügner, *m.* liar.
Nachtheil, *m.* disadvantage.
Nutzlos, useless.
Men'schengeschlecht', *n.* mankind.
Pfeifchen, *n.* little pipe.
Rinderbraten, *n.* beef.
Schatz, *m.* treasure.

Schlafen, to sleep.
Schul'digkeit, *f.* obligation, duty.
Stück, *n.* piece.
Teich, *m.* pond.
Trägheit, *f.* idleness.
Umge'bung, *f.* neighbourhood, environs.
Un'bekümmert, unconcerned, careless.
Universität', *f.* university.
Verhält'niß, *n.* relation, circumstance, situation.
Wildpret, *n.* venison.
Wohlfahrt, *f.* welfare.
Zu'bringen, to pass, spend.

EXERCISE 142.

Translate into English:—

1. Er bringt seine Zeit mit Nichtsthun zu. 2. Er brachte den größten Theil seiner Jugend auf den Gymnasien und Universitäten seines Landes zu. 3. Die meiste Zeit bringt er mit nutzlosen Beschäftigungen zu. 4. Viele Menschen bringen ihre Zeit mit Essen, Trinken und Schlafen zu. 5. Einem jeden Menschen, der nur ein Fünkchen Gefühl hat, geht nichts über sein Vaterland und über die Wohlfahrt desselben. 6. Es geht nichts über die Ruhe der Seele, und das Bewußtsein, seine Schuldigkeit gethan zu haben. 7. Er sagte, seine größte Freude und sein größter Schatz seien seine Kinder, und nichts gehe ihm über dieselben. 8. Ein Matrose sagte, es gehe ihm nichts über ein Pfeifchen. 9. Dem Gleichgültigen ist zwar Vieles einerlei; wer aber sagt, es sei ihm Alles einerlei, ist ein Lügner. 10. Was man versprochen hat, soll man halten, einerlei, ob Nachtheil oder Vortheil daraus entsteht. 11. Dem Soldaten muß im Kriege Alles eins sein. 12. Ein rechter Mann schickt sich geduldig in alle Verhältnisse; es ist ihm Alles eins, was er thut, nicht aber, wie er es thut. 13. Seit dem Tode seiner Kinder ist ihm Alles eins; er ist gleichgültig gegen seine Umgebung, und unbekümmert um den Gang seiner Geschäfte. 14. Ein jeder Mensch hat seinen freien Willen; deßhalb geht es mich nichts an, wie er seine Zeit verwendet. 15. Ich reiste über Rotterdam und London nach Amerika. 16. Der Freund ging soeben über die Straße. 17. Der arme Knabe dauerte ihn, deßhalb nahm er ihn zu sich in sein Haus, und ließ ihm eine ordentliche Erziehung geben. 18. Wen das Vieh nicht dauert, und wer unbarmherzig gegen dasselbe ist, den dauert auch ein Mensch nicht.

EXERCISE 143.

Translate into German:—

1. Many people pass their time in idleness. 2. He spent the greatest part of his life in foreign countries. 3. Any man who has a touch of honour renounces no duties which will benefit mankind. 4. He says his greatest treasure was God, and the whole world is as nothing compared to Him. 5. This man said it were all the same to him whether his undertakings were successful or not. 6. How many sorts of wine have you? 7. I have three sorts; you may choose which you like. 8. I go every day twice over London Bridge. 9. Many go to Germany by way of Ostend. 10. I shall probably spend one month in Bonn. 11. My neighbour has three different kinds of ducks in his pond; they are very beautiful. 12. We have three sorts of roses growing in our garden. 13. When I am hungry, it is the same to me whether I have venison or a piece of beef before me. 14. He bought ribbons of three sorts of colours.

Verlassen,' Abhängen.

Verlassen, when used reflexively, signifies "to depend upon," "to rely upon," as:—Ich verlasse mich auf Ihr Wort, I depend upon your word (I leave myself upon your word).

Abhängen, likewise, signifies "to depend upon," "to be dependent upon," as:—Es hängt von Umständen ab, it depends upon circumstances. Thence is derived the adjective abhängig (dependent), as:—Er führt ein abhängiges Leben, he leads a dependent life; Die Vereinigten Staaten erklärten sich als ein unabhängiges Volk, the United States declared themselves (as) an independent people.

EXAMPLES.

Ich kann nicht darein'willigen.	I cannot agree to it.
Er wil'ligte unverzüglich darein'.	He agreed (consented) to it unhesitatingly.
Diese Leute stellen sich, als ob sie von Sinnen wären.	These people act (place themselves) as if they were out of their senses.
Es widerfährt' uns in unserm Leben manches Glück und manches Unglück.	There happens to us in our lives (many a) much happiness and many a misfortune.
Es widerfährt' Manchem mehr Ehre, als er verdient'.	There happens to many a one more honour than he deserves.
Der Vogel ist zum Fenster hinaus'geflo'gen.	The bird has flown out of the window.
Die Freunde entzwei'ten sich.	The friends quarrelled (separated themselves).
Die Pflaume ist ein Steinobst.	(The) plums are a stone fruit.
Sie verlie'ßen sich darauf', daß er sein Versprech'en halten würde.	They relied upon his keeping his promise.
Man soll nie eher in eine Sache ein'willigen, als bis man diesel'be wohl überlegt' hat.	One should never assent to a thing before one has well considered it (the same).
Ist es nicht, als ob dieses Volk mich zum Gotte mache? (Schiller.)	Is it not as though this people would make me a god?

VOCABULARY.

- Ab'hängig, dependent.
- Beding'ung, *f.* condition, stipulation.
- Darein'willigen, to consent.
- Entzwei'en, to fall out, disunite, quarrel.
- Fä'higkeit, *f.* ability.
- Folge, *f.* sequel, consequence.
- Frucht, *f.* fruit.
- Geber'den, to behave.
- Gemäch'lich, comfortable, easy.
- Gera'de, exactly.
- Gera'then, to turn out, succeed.
- Hinaus', out, out there.
- Hinaus'eilen, to hasten out.
- Hinaus'werfen, to throw out.
- Kana'rienvogel, *m.* canary-bird.
- Öffnen, to open.
- Umstand, *m.* circumstance.
- Un'abhängig, independent.
- Verschmä'hen, to disdain, despise.
- Wohl'meinen, to mean well, wish well.
- Zu'dringlich, obtrusive.

EXERCISE 144.

Translate into English :—

1. Dieses Jahr ist das Obst, sowie alle Früchte, wohl gerathen. 2. Dieser Baum trägt jedes Jahr sehr viele Früchte. 3. Sind alle Früchte Obst? 4. Nein, nicht alle, sondern nur solche, die an Bäumen wachsen. 5. Dieser junge Mann verläßt sich zu viel auf seine Verwandten und zu wenig auf seine eigenen Fähigkeiten. 6. Er verläßt sich darauf, daß wir ihn die nächste Woche besuchen. 7. Er verließ sich darauf, daß ihm Gott helfen werde. 8. Wer sich zu viel auf Andere verläßt, kann leicht getäuscht werden. 9. Ich halte viel auf meine Freunde. 10. Er hält viel auf ein gemächliches Leben. 11. Dieser Mann hält zu viel von sich und seiner Klugheit, weßhalb er den Rath wohlmeinender Freunde verschmäht. 12. Nur unter dieser Bedingung kann ich dareinwilligen. 13. Ich willige darein, in so fern es keine üblen Folgen hat. 14. Er willigte darein, ohne mit allen Schwierigkeiten bekannt zu sein. 15. Dieses Kind thut gerade, als ob es hier zu Hause wäre. 16. Der Matrose stellte sich, als ob er von Sinnen wäre. 17. Er geberdet sich, als ob ihm das größte Unrecht widerfahren wäre. 18. Dieser Mann stellt sich, als ob er beleidigt wäre. 19. Er stellt sich wie ein Kind von fünf Jahren. 20. Der Nachbar warf den Zudringlichen zur Thüre hinaus.

EXERCISE 145.

Translate into German :—

1. Last year the fruit did not turn out well. 2. This tree yields fruit but seldom. 3. This young gentleman relies too much upon his abilities. 4. No, he does not rely too much upon his abilities, but he knows it is not well to be dependent upon those of others. 5. I rely upon you that you will visit me next week. 6. Do exactly as if you were at home. 7. The criminal acted as if he were out of his senses. 8. This man acts exactly as a child. 9. Where is your canary-bird? It is flown out of the window. 10. How can I assent to a thing which is against my inclination? 11. Whoever quarrels shall be expelled the house. 12. It depends upon circumstances whether I shall go to my friends. 13. Every man strives to be independent. 14. Depend upon it that I shall not help you again.

Nichts können.

Nichts or nicht dafür können signifies "not to be in fault," *or* "to blame." as:—Ich kann nichts dafür, it is not my fault, *or* I cannot help it (*lit.*, I cannot *or* can nothing therefore); Er kann nichts dafür, daß er so arm ist, he cannot help it—that is, he is not to blame —that he is so poor. So also interrogatively, as:—Kann die Welt etwas dafür, daß sich ein großer Geist in ein schlechtes Kleid versteckt? (Rabener), is the world to blame, that a great soul conceals itself in a plain dress? that is, Die Welt kann nichts dafür.

EXAMPLES.

Ich kann nichts dafür', daß ich mein Geld verlo'ren habe.	It is not my fault that I have lost my money.
Diese Uhr geht vor (or zu schnell), und jene geht nach (or zu langsam).	This watch goes too fast, and that (one) goes too slow.
Hat man mein Zimmer in Ordnung gebracht'?	Has my room been put in order?
In der Reihe seiner Schmeichler hat er keinen wahren Freund.	In the ranks of his flatterers he has not a true friend.
Es giebt Viele, die glauben, daß in den meisten Fällen das Glück oder Unglück eines Menschen vom Zufall ab'hänge.	There are many who believe that, in (the) most cases, the fortune or misfortune of a man depends on chance.
Leben Sie wohl, mein Herr, und empfeh'len Sie mich gütigst Ihrer Frau Gemah'lin.	Farewell, Sir, and please remember me kindly to your wife.

VOCABULARY.

- An'geben, to give, specify.
- An'strengung, *f.* exertion, effort, labour.
- Bereit', ready.
- Beruf', *m.* calling, vocation.
- Beru'higen, to quiet.
- Bestim'men, to fix, determine.
- Dafür', therefore, for it.
- Dank, *m.* thanks, acknowledgment.
- Erret'ten, to save, rescue, deliver.
- Furcht, *f.* fear, dread.
- Kern, *m.* kernel.
- Kutscher, *m.* coachman.
- Ordnung, *f.* order, regulation.
- Teller, *m.* plate.
- Umschlie'ßen, to enclose, surround.
- Um'werfen, to upset
- Un'ordentlich, disorderly, irregular, confused.
- Unterlas'sen, to leave off, omit, fail.
- Un'würdigkeit, *f.* unworthiness, indignity.
- Verder'ben, to spoil, corrupt, destroy.
- Verzicht'en (auf Etwas), to resign—*i.e.*, as a privilege or a claim on anything.

Vor'gehen, to go before, go too fast.
Wagen, *m.* carriage.
Weisheit, *f.* wisdom.
Wesen, *n.* existence, being.
Zerbre'chen, to break (in pieces).

Exercise 146.

Translate into English:—

1. Sie können nichts dafür, daß Sie so unglücklich sind. 2. Er konnte nichts dafür, daß er dieses Glas zerbrach. 3. Ich kann nichts dafür geben, als meinen Dank. 4. Die Gründe dafür werde ich angeben, wenn es verlangt werden sollte. 5. Können Sie mir sagen, wie viel Uhr es ist? 6. Nein, denn meine Uhr ist stehen geblieben. 7. Steht Ihre Uhr schon lange? 8. Ja, beinahe eine Stunde. 9. Meine Uhr geht zu schnell, sie geht beinahe eine halbe Stunde vor. 10. Die Uhr meines Freundes geht fünf Minuten vor. 11. Leben Sie wohl, und vergessen Sie nicht, mich bald wieder zu besuchen. 12. Leben Sie wohl, mein Herr! 13. Wann wollen wir zusammen Herrn N. besuchen? 14. Es hängt ganz von Ihnen ab welche Zeit Sie dazu bestimmen wollen, ich bin zu jeder Zeit bereit, mitzugehen. 15. Es hängt von Ihnen ab, diese Familie zu erretten oder verderben. 16. Der Nachbar arbeitet in seinem Garten und sucht denselben in Ordnung zu bringen. 17. Bei aller Anstrengung bringt er diese Sache nicht in Ordnung. 18. Er suchte mich in die Reihe seiner Kameraden zu bringen. 19. Es hält schwer einen unordentlichen Menschen an Ordnung zu gewöhnen. 20. Nach vieler Muhe hat er die Rechnung in Ordnung gebracht.

Exercise 147.

Translate into German:—

1. It is not my fault that you have had the mishap. 2. You are not to blame that the servant has broken the plate. 3. He could not give me anything for it, except his thanks. 4. He could not help it; he only spoke the truth. 5. Is the coachman to blame that the carriage was upset? 6. No, he is not to be blamed, for the horses could not be quieted. 7. Can you tell me what time it is? 8. No, my watch goes too slow. 9. To fix the hour of my departure depends upon my parents. 10. Farewell, Madam; please do not forget to remember me to your parents. 11. It depends upon you what time you will fix to visit your friends; I shall always be ready to accompany you. 12. Fortune and misfortune, life and death, poverty and riches—all depend on the will of God.

Sich Verstehen, Sagen, etc.

Sich verstehen (to understand oneself). with auf, signifies "to be a judge of," "to be skilled in," as:—Er versteht sich auf Alles, he is skilled in everything.

Es versteht sich (*lit.*, it understands itself—that is, it is understood, is self-evident) answers to our phrase "of course," *or* "as a matter of course," as:—Es versteht sich, or Es versteht sich von selbst, daß ich meinen Eltern gehorchen muß, of course, *or* as a matter of course, I must obey my parents. The word natürlich (naturally) is often used in the same manner, as:—Natürlich muß es so sein, of course it must be so.

Sagen answers to the English "say" or "tell;" "to tell" or "narrate," however, is expressed in German by erzählen, as:—Was sagte er? what did he say? Was hat er Ihnen gesagt? what has he told (*or* said) to you? Der alte Matrose erzählte eine rührende Geschichte, the old sailor told (*or* related) a moving (affecting) story.

Fort is often expressed in English by "gone off," etc., as:—Ist er schon lange fort? has he already been *gone* long?

Es sei denn, daß = "unless," "except," as:—Der Mensch kann nicht wahrhaft glücklich sein, es sei denn, daß er tugendhaft sei, man cannot be truly happy unless he be virtuous; Wahrlich, wahrlich, ich sage dir: Es sei denn, daß Jemand von Neuem geboren werde, kann er das Reich Gottes nicht sehen, Verily, verily, I say unto thee, except a man be born again, he cannot see the kingdom of God.

Examples.

Wissen Sie, wie weit Sie in der Sache zu gehen haben?	Do you know how far you have to go in the matter? (how far you are at liberty to go).
Einen wie langen Spazier'ritt haben Sie gemacht'?	How long a (pleasure) ride have you taken?
Es versteht' sich von selbst, daß ein fauler Schüler keine Fort'schritte machen kann.	It is self-evident that a lazy scholar can make no progress.
Dieser Italie'ner versteht' sich auf Musik'.	This Italian is a judge of music.
Herr M. ist heute Morgen fort nach Nord-Ame'rika.	Mr. M. left (is off) this morning for North America.
Wohin' eilen Sie so schnell?	Whither are you hastening so rapidly?
Ich gehe zu dem Zahn'arzte.	I am going to the dentist.
Die Sache sei nun, wie sie wolle, ich werde ihm nicht verzei'hen, es sei denn, daß er mich um Entschul'digung bitte.	Well, be it (the thing) as it may, I shall not forgive him unless he ask my pardon.

Vocabulary.

Anwalt, *m.* attorney, defender.
Bahnen, to open (as a path), facilitate.
Ende, *n.* end.
Fort'gehen, to go away.
Hin'kommen, to come, get to.
Park, *m.* park.
Pflanze, *f.* plant, vegetable.
Schein, *m.* shine, light.
Scherz, *m.* jest, sport.
Stören, to trouble, disturb.
Türkisch, Turkish.
Verschwen'derisch, prodigal, lavish, profuse.

EXERCISE 148.

Translate into English:—

1. Der Dieb ist seines Verbrechens überführt worden, und es versteht sich von selbst, daß er bestraft werden wird. 2. Der Vater ist seit heute Morgen fort und bis jetzt noch nicht wieder zurückgekehrt. 3. Das Buch ist fort, und keiner dieser Schüler will wissen, wo es hingekommen ist. 4. Meine Neffen sind fortgegangen, ohne zu sagen, wohin sie gingen. 5. Unser Obst ist alle. 6. Auch noch so vieles Geld wird alle, wenn man verschwenderisch ist. 7. Der türkische Kaiser Soliman II. sagte kurz vor seinem Tode: „Meine Kräfte sind zu Ende, nicht aber mein Muth." 8. Wie weit gehen Sie spazieren? 9. Ich gehe, bis ich müde werde, gewöhnlich bis an den Park. 10. Mein Freund weiß recht gut, wie weit er in dieser Sache zu gehen hat. 11. Man muß selbst im Scherze wissen, wie weit man zu gehen hat; denn auch im Scherze kann man beleidigen. 12. Wo gehen Sie hin? 13. Ich gehe zu meinem Anwalt. 14. Wie weit haben Sie zu gehen? 15. Bis an das Ende der Stadt. 16. Wie lange haben Sie zu gehen? 17. Über eine Stunde. 18. Einen wie weiten Spaziergang haben Sie gemacht? 19. Ich bin bis in der Nähe des Flusses gewesen. 20. Einen wie langen Spaziergang haben Sie gemacht? 21. Ich bin über eine halbe Stunde spazieren gegangen. 22. Wie lange sind Sie aus dem Hause gewesen? 23. Ich war dreiviertel Stunden aus demselben. 24. Waren Sie weit von demselben entfernt? 25. Ich bin beinahe eine halbe Stunde weit von demselben entfernt gewesen. 26. Ich hoffe euch wiederzusehen, sei es nun in dieser, oder sei es in jener Welt.

EXERCISE 149.

Translate into German:—

1. Tell me if that is your own horse? 2. That farmer told me many things about agriculture. 3. I shall not go out to-day unless necessity compels me. 4. You will not enter the kingdom of heaven unless you acknowledge the blessings of God. 5. My brother went off yesterday, and we have heard nothing of him. 6. It is self-evident that without nourishment man, animals, and plants cannot exist. 7. My knife is gone, and none of the children know where it is. 8. Our money is all gone. 9. I know very well how far I have to go in this matter. 10. Where do you go to? 11. I am going to my brother. 12. How far have you to go? 13. Just to the park. 14. What distance have you to go? 15. About three quarters of a mile. 16. He believed the time had now arrived to open his own path through life.

KEY TO TRANSLATION FROM GERMAN (p. 191).

In the calm bay of Pallon we heard for the first time that which till now we thought impossible: singing fish. At our side, around us, deep out of the earth, there sounded everywhere a wonderful, half-complaining, drifting voice, just like a far-off melodious sound of an organ or bells, which, as our pilot assured us, came from a kind of fish. It is said to be a small, very shy fish, which utters this sound, and it is very seldom caught. Once, some time since, one of the fishermen of these parts by chance caught such a fish as we have described in his net, and while still in the net he uttered the sound. Perhaps in superstitious fear he let him free again in a moment, for the people here naturally tell the most wonderful stories of the fish—or rather of the voices—which they take to be the souls of drowned men.

KEY TO EXERCISES.

Ex. 132.—1. It was an agreeable hour, was it not, my friend? 2. Yes, that it was, and I shall not very soon forget it. 3. The neighbour was also at the feast, was he not? 4. Yes, he was there, and very merry. 5. It is surely very late, is it not? 6. No, it is still early. 7. It is not all true what people say, is it? 8. No, one cannot believe them in everything. 9. I have already waited an hour for him, and yet he does not make his appearance. 10. We are waiting for the waiter who is waiting upon us. 11. I will wait upon you this afternoon, if you please. 12. May I help you to a cup of tea or coffee? 13. I thank you for (your offer of) tea; but, if you please, I will take a cup of coffee. 14. The princes who were present at the coronation of the German emperors at Aix-la-Chapelle waited at table. 15. In vain have I called his attention to it; he only follows his own caprice. 16. The teacher reminded the scholars how admirably and excellently God has regulated everything in the world.

Ex. 133.—1. Ihr Freund, welchen wir vorgestern sahen, ist krank, nicht wahr? 2. Es war ein angenehmer Abend, nicht wahr, mein Freund? 3. Ja, das war es, und nie werde ich das Vergnügen vergessen, welches wir hatten. 4. Nicht wahr, Ihr Herr Bruder war auch da? 5. Es ist noch früh, nicht wahr? 6. Nein, es ist sehr spät, und wir müssen gehen. 7. Ich habe schon eine Stunde auf meinen Freund gewartet, aber er ist noch nicht gekommen. 8. Ich warte auf unsern Diener. 9. Warten Sie nicht auf ihn, ich ihn habe soeben ausgeschickt. 10. Als ich in London ankam, ging ich gleich zu meinem Freunde an welchem ich Empfehlungsbriefe hatte, und machte ihm meine Aufwartung. 11. Darf ich Ihnen mit einer Tasse Chocolade aufwarten? 12. Ich danke Ihnen.

Ex. 134.—1. It grieves me to see so many people unhappy. 2. The wound pains him more and more every day. 3. Nothing grieves one more than to be mistaken by people whose love and esteem one wishes to obtain. 4. I am sorry that I have offended him. 5. Parting and avoiding give pain, says an old German national song. 6. My head aches. 7. It grieves me to the heart not to be able to assist him. 8. What is the matter, my friend? why so sad? 9. Nothing ails me, except that I am a little out of humour. 10. Are you ill? 11. Yes, I am a little indisposed. 12. What ails you? 13. I have a headache. 14. You are rich and respected, and yet you are dejected; what ails you? 15. I am much in want of "contentment and tranquillity of mind." 16. All my friends who had promised to come were there, one alone excepted. 17. All men are subject to commit errors (*lit.*, all men fail). 18. My brother missed the way again; instead of coming into my house, he went into that of my neighbour. 19. He repented of his words, and promised that he would never say so again. 20. When this happened, I was not at home.

Ex. 135.—1. Es schmerzt einen Vater, von der Gottlosigkeit seines Sohnes zu hören. 2. Nichts schmerzt mehr, als unschuldig angeklagt zu sein. 3. Es schmerzt mich, daß man

so viele Menschen gefunden hat, die durch den letzten Sturm umgekommen sind. 4. Es thut mir leid, daß Sie mich nicht zu Hause gefunden haben. 5. Die Wunde, welche der Soldat in dem Streite erhielt, schmerzt ihn. 6. Was fehlt Ihnen, mein Freund? 7. O! nichts besonderes. 8. Sie sehen sehr krank aus, was fehlt Ihnen? 9. Ich bin nicht wohl, ich habe mir weh gethan. 10. Er ist aus dem Fenster gefallen. 11. Es fehlt diesem Knaben an Verstand. 12. Sie sind von mir beleidigt worden; es thut mir leid, denn ich achte Sie sehr. 13. Es darf Ihnen nicht an Muth fehlen um dem Streite mit Ihrem Feinde entgegen zu gehen. 14. Es fehlt mir an Geduld, den Erfolg dieser Sache abzuwarten.

Ex. 136.—1. Since I arrived here, many things have occurred already. 2. Since he committed this deed, all peace seems to have forsaken him. 3. From the time he left I have not had a thoroughly happy hour. 4. Since this time one has heard nothing of him. 5. I left my parental home at ten years of age. 6. I have not felt myself quite well since yesterday. 7. Since the death of his parents he has been roving in foreign lands, destitute of home. 8. Since he has become conscious of himself, he is quite a different person. 9. He dressed himself with all haste. 10. In his hurry he forgot to put on his boots, and ran off in his slippers. 11. His clothes were wet through, consequently he was obliged to change his dress. 12. This morning he did not put on his hat, but his cap. 13. The servant did not as usual help his master to put on his cloak, but the latter put it on himself. 14. Do not forget to put on your cloak; it is very cold and stormy. 15. Please put on my cloak and hat, as I have already got my thick fur gloves on. 16. He climbed up the highest tree, that he might be able to see the king. 17. He was in great haste, that he might not miss the starting of the stage-coach. 18. He told me this, that it might be an example to me. 19. The scholar excused himself by saying that he had no time to learn his exercise. 20. In great states hundreds must starve, in order that one may gormandise and revel; tens of thousands are oppressed and hunted to death, that one crowned fool or philosopher may gratify his whims.

Ex. 137.—1. Wollen Sie mir gefälligst eine Tasse Kaffee oder Thee geben? 2. Seit gestern habe ich mich nicht ganz wohl gefühlt. 3. Seitdem er sein elterliches Haus verlassen hat, haben wir nichts von ihm gehört. 4. Seit meinem zwölften Jahre habe ich mein Vaterland nicht besucht. 5. Seitdem er die Nachricht erhielt, hat er keine Ruhe gehabt. 6. Damit mein Freund nicht vergebens komme, werde ich zu Hause bleiben. 7. Ich habe meinen Freund nicht gesehen, seitdem er von Deutschland angelangt ist. 8. Anstatt seine Stiefel anzuziehen, ging er in den Pantoffeln aus. 9. Sagen Sie gefälligst Ihrem Freunde, er könne uns zu jeder Zeit besuchen. 10. Warum benutzt er seine Jugend nicht, um die Kentnisse zu erwerben, die er gebraucht. 11. Wie haben Sie sich befunden, seitdem ich Sie zuletzt sah? 12. Beendige deine Aufgabe, wenn du sie noch nicht beendigt hast, dann wirst du von deinem Lehrer nicht bestraft werden.

Ex. 138.—1. I am glad to meet with you here; I have important matters to communicate to you. 2. I am glad to see you so well. 3. I should be glad to see you again soon. 4. He is angry at the behaviour of his nephew. 5. He is angry on account of his son's staying out. 6. She is angry with herself. 7. The friend was vexed with me, but I have pacified him again. 8. The mother is angry with her stubborn child. 9. I am angry with him, because he has offended me. 10. Do you know Mr. N.? 11. Yes, I became acquainted with him last week at your aunt's house. 12. I become better acquainted with him every day. 13. One becomes acquainted with anybody sooner than with oneself. 14. Where did you become acquainted with this gentleman? 15. We have known each other from our youth, and become better acquainted every day. 16. Do you know Miss B.? 17. No, but I hope yet to become acquainted with her. 18. This man will soon become known through his excellent works. 19. Mr. N. introduced me to this family. 20. Ho was introduced to the company by his brother.

Ex. 139.—1. Es würde mir sehr angenehm sein, wenn Sie mich zufrieden ließen. 2. Es war sehr befriedigend für mich, meinen Bruder wohl zu sehen. 3. Es ist mir sehr lieb zu hören, daß Ihr Unternehmen gelungen ist. 4. Er ist böse über das Betragen seines Bruders. 5. Mein Bruder stellte mich Herrn G. vor. 6. Ist Ihre Schwester schon mit meinem Bruder bekannt geworden? 7. Ja, sie lernte ihn in dem letzten Concerte kennen. 8. Wissen Sie, warum Ihr Bruder so böse ist? 9. Er ist böse auf mich, weil ich über ihn lachte. 10. Der Schauspieler stellte Heinrich IV. sehr gut vor. 11. Jene Regierung hat gute Gesetze eingeführt. 12. Diese Mode ist von den Franzosen eingeführt worden. 13. Die Wein-Einfuhr von Frankreich ist sehr groß.

Ex. 140.—1. My little brother has a cold; he caught a violent cold on the ice. 2. He who is overheated and cools himself too quickly may soon catch cold. 3. We ought not to trouble ourselves about things which do not concern us. 4. As far as this affair concerns me, I have taken the necessary steps. 5. This does not concern you. 6. At this intelligence he stood as if struck with the palsy. 7. The palsy has struck the old man. 8. The man has been struck with the palsy. 9. She sank down as if struck with the palsy. 10. These goods sell well. 11. When does the next steamer leave? 12. I do not see that this man stints himself in anything. 13. Has the session passed off quietly? 14. No, it has not passed off quietly; the debate was very stormy. 15. This book had a great sale. 16. The young merchant told me that the sale had considerably increased. 17. Just as the fancy takes me, I shall start from here. 18. According as ho is disposed, he can be the most pleasant, but also the most quarrelsome man. 19. According as he begins it will be his success. 20. As far as I can be useful to you, I will do it with all my heart.

Ex. 141.—1. Meine Schwester hat den Schnupfen; sie hat sich an einem nassem Abende erkältet. 2. Jene Sache geht mich nichts an, und deßhalb werde ich mich nicht darum bekümmern. 3. Ist der Zug schon abgegangen. 4. Nein, er ist noch nicht abgegangen. 5. Ist der Zug nach Oxford abgegangen? 6. Es sind schon zwei Züge nach Oxford diesen Morgen abgegangen. 7. Ist die Debatte ruhig abgegangen? 8. Nein, es war eine sehr stürmische. 9. Englische Waare geht in jedem Lande gut ab. 10. Diese Grammatik geht gut ab. 11. Nach euren Kenntnissen werdet ihr belohnt werden. 12. Seitdem er vom Schlage gerührt worden ist, ist er nicht im Stande gewesen sein Geschäft zu versehen. 13. Er wurde vom Schlage gerührt während unseres Besuches in Ihrem Hause. 14. In so fern es mich angeht, werde ich jede Vorsicht gebrauchen. 15. Trotz ihrer Armuth lassen sich diese Leute

nichts abachen. 16. Den Menschen ist nichts besser, als eine gute Erziehung. 17. Ich weiß nicht, ob er meine Bitte gewähren wird.

HYDRAULICS.—III.

[Continued from p. 252.[?]]

WATER SEEKS ITS OWN LEVEL—STORE OF ENERGY DUE TO HEAD OF WATER—PRESSURE AT DIFFERENT DEPTHS IN STILL WATER—SPECIFIC GRAVITY OF LIQUIDS IN EQUILIBRIUM—CAPILLARITY AND SURFACE-TENSION.

THE atmospheric pressure acts uniformly on the free surface of still water, and always at right angles to that surface. When water is contained in vessels of different shapes and heights, all in free communication with one another, and with the same reservoir in an elevated position, by a common main pipe, we find the water seeks its own level, and stands at the same height in all the vessels when there is no flow or motion in the water as a whole. The water-supply to towns from a reservoir depends on this tendency of water to rise in the system of pipes in the houses to the same level as the free surface in the reservoir. If a pipe, ending in an open nozzle far below this *free surface level*, be put into communication with a water-main of the town supply, the water will spout out of the nozzle and rise up to a considerable height, though it will never quite reach the level of the water in the reservoir. This is no longer true when water is in motion.

In case of the motion of liquids, experiment shows that the tendency invariably is for water and every other liquid to flow from places of high to places of lower surface level. The capability of water to do work owing to its position or height above some given datum line is called its potential energy. Thus w pounds of water at a height h feet above some datum level is said to possess a store of potential energy equal to wh foot-pounds, since it would do wh foot-pounds of work in falling. The mechanical energy stored up in water contained in a dam or reservoir is simply the weight of the water multiplied by the height through which it can fall doing work.

As the water falls *freely*, under the action of gravity, down a waterfall, its store of potential energy is gradually changed into energy of motion, or kinetic energy. A body of mass, m, when moving with a velocity of v feet per second, has a store of kinetic energy, due merely to its motion, equal in amount to half the product of the mass into the square of its velocity—that is,

$$\text{Kinetic energy} = \frac{1}{2} m v^2 \text{ ft.-lb.}$$

Now, the mass or quantity of stuff in a body is measured by its weight in pounds divided by g, the intensity of gravity at the place. In fact, the weight of a body is due to the downward pull or attraction of the earth on the mass of the body. One of the effects of a force when applied to a given mass is to accelerate its motion, and

$$\text{force} = \text{mass} \times \text{acceleration}.$$

The acceleration of bodies falling freely by the attraction of the earth is called g, the intensity of gravity at the place. At London, g is 32·18; and for Great Britain g is about 32·2; so that the weight of a body will vary with g according to its position on the earth's surface, and

$$\text{Weight} = \text{mass} \times \text{gravity}.$$

In other words,

$$\text{Mass of a body} = \frac{\text{weight of body in lb.}}{32 \cdot 2}.$$

Hence it follows that if we substitute this value for the mass m in the above expression for kinetic energy, we have

$$\text{Kinetic energy} = \frac{\text{weight in lb.}}{2 \times 32 \cdot 2} \times (\text{velocity})^2$$

$$= \frac{w}{64 \cdot 4} v^2 \text{ ft.-lb.}$$

In the case of the waterfall, w lb. of water, moving at v feet per second at the bottom of the fall, has its potential energy converted into kinetic energy, and before its motion is stopped, it is capable of doing $\frac{wv^2}{64 \cdot 4}$ ft.-lb. of work. On the other hand, if the water had been allowed to overcome resistance, and thus do work as it fell, then its potential energy would have been gradually converted into work, and there would not have been the same store of kinetic energy remaining in it at the bottom. This is on the assumption that there is no loss by friction, and that the pressure of the water remains always the same throughout the fall. The total store of energy remains the same; and during the fall the store of potential energy becomes gradually converted into kinetic energy.

EXAMPLE 1.—The level of water falls 6 inches in a circular reservoir, 50 feet in diameter; what total amount of work can be done by this mass of water falling freely to a datum level 60 feet below the free surface of the water remaining in the reservoir?

In the first place, we must find the volume and weight of the water that must have fallen to reduce the surface-level in the reservoir 6 inches. The area of the water surface is $\frac{\pi}{4}d^2$, that is,

$$\cdot 7854 \times 50^2 = 1963 \cdot 5 \text{ square feet.}$$

The volume of the mass of water, 6 inches, or ·5 foot deep and 1963·5 square feet in area, is

$$1963{\cdot}5 \times {\cdot}5 = 981{\cdot}75 \text{ cubic feet.}$$

The weight of this water at 62·4 lb. per cubic foot is

$$981{\cdot}75 \times 62{\cdot}4 = 61261{\cdot}2 \text{ lb.}$$

Now, the top layer of this water fell 60 feet 6 inches, and the lowermost layer only fell 60 feet, so that the average height of fall is 60 feet 3 inches, or 60·25 feet; and therefore the work that the water was capable of doing equals

$$61261{\cdot}2 \times 60{\cdot}25 \text{ ft.-lb.}$$
$$= 3{,}690{,}987 \text{ ft.-lb.} \qquad \textit{Answer.}$$

EXAMPLE 2.—Suppose the water in this example flowed away at such a rate as to reduce the free surface level the 6 inches in 1 hour, what would be the horse-power of the water falling?

The rate of doing work is called the *power*, and one horse-power is the rate of doing 33,000 foot-pounds of work per minute.

Since the whole work is done in 1 hour, the average rate of working per minute is

$$\frac{3690987}{60} = 61516{\cdot}45 \text{ ft.-lb. per minute.}$$

But the rate of doing 33,000 ft.-lb. per minute is called 1 horse-power, so that the water in falling at the above rate is capable of developing

$$\frac{61516{\cdot}45}{33000} = 1{\cdot}864 \text{ horse-power.} \qquad \textit{Answer.}$$

Had the water fallen in one-tenth the time—that is, in 6 instead of 60 minutes—then the power of the fall would have been equal to ten times the above amount, or 18·64 horse-power. We see, then, it is a matter of great practical importance to determine the flow of water. However, before doing so, we must consider the variation in the pressure at different depths in still water.

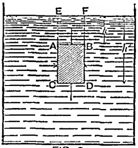


FIG. 9.

Imagine a portion, A B C D, of a liquid of uniform density to become solidified, or jelly-like, whilst remaining in every other respect the same as the rest of the liquid in the vessel (Fig. 9)—that is, without altering in density or otherwise affecting the rest of the mass.

The liquid is at rest, and the pressure at any point in it is the same in all directions. Suppose the column A B C D to be a vertical cylinder of exactly the same stuff as the other portions of the liquid.

The pressure on its sides is normal to A D and B C, and therefore entirely horizontal, being at the same time exactly equal in intensity and opposite in direction at any level, as shown by the arrows, so that all the horizontal pressures equilibrate one another. The only other forces acting on the cylinder are vertical in direction. These are the weight of the cylinder, A B C D, which acts downwards; the total pressure on the upper end, A B, equal to the weight of the column A B E F above it; which also acts downwards; and on the lower end D C the total pressure acts upwards. Since the cylinder A B C D remains at rest under the action of these forces, it follows that the total pressure on the lower end, D C, must exceed that on the upper end, A B, by an amount equal to the weight of the liquid cylinder, A B C D, itself.

That is, the total resultant upward pressure on the cylinder—namely, the difference between the pressures on the two ends—is equal to the weight of the column of liquid, A B C D.

In other words, the resultant force on the column A B C D immersed in a liquid, and in equilibrium, is a total upward pressure equal to the weight of the liquid displaced.

We must dwell on and consider carefully the conclusions to be deduced from these two important statements.

1. Let a represent the sectional area of the cylinder, namely, the horizontal area of A B or D C, exposed to the pressure of the liquid. Suppose the intensities of pressure on the upper and lower ends of the cylinder to be p and p' respectively, at the depths h and h' below the free surface level.

We have, then,

ah = volume of liquid column A B E F,
ah' = ,, ,, ,, E D C F,
and $a(h'-h)$ = ,, ,, ,, A B C D.

Multiply each of these by w, and we find the weight of the corresponding column of liquid thus:—

wha = weight of liquid column A B E F of height, h, standing on the horizontal base, A B, of area, a; and $w(h'-h)a$ = weight of the liquid cylinder, A B C D. Now, pa = the total downward pressure on the upper end, A B; and $p'a$ = total upward pressure on the lower end, D C; so that the difference $(p'-p)a$ must be the total resultant upward pressure on the cylinder A B C D. This pressure is exactly counterbalanced by the weight of the column A B C D, since it remains at rest, and

$$(p'-p)a = w(h'-h)a,$$
or
$$p'-p = w(h'-h).$$

that is, the pressure increases in amount $p'-p$, as the depth increases from h to h'. Therefore, *in the same liquid the pressure increases directly as the depth below the free surface level.*

This may also be clearly seen by considering

separately the conditions of equilibrium of the layers of liquid at the ends, AB and CD, of the imaginary column.

If p be the intensity of pressure at depth h, then pa is the total downward pressure on the horizontal area a at this depth. This must be equal to the weight of the column of liquid, ABEF, standing on the horizontal area, a, as base, and of height, h. The weight of this liquid column is wha, neglecting the pressure on the free surface EF, due to the weight of the column of air standing on it; hence the total downward force on the horizontal area a is

$$pa = wha,$$

or

$$p = wh.$$

For all points on a thin horizontal layer of liquid the pressure will be the same, so long as w and h are not changed.

In the same way, at DC the intensity of pressure on unit area immersed at a depth h' is

$$p' = wh',$$

always on the assumption that the liquid is practically incompressible, so that w, the weight of unit volume, is the same everywhere throughout its mass.

We thus see that *in the same liquid the pressure varies directly as the depth.*

Further, what is the total resultant pressure on a thin plate, or on any surface, immersed in a liquid?

When the area, a, is horizontal at a depth, h, below the free surface level, in a liquid of weight w per unit volume, then

$$\text{Total pressure} = wha.$$

In general, it can be shown that the whole pressure on any surface immersed in a liquid equals the weight of a column of the liquid standing on that area for base, and whose height is the depth of the centre of gravity of that area below the free surface level of the liquid.

In the case of a surface immersed in water, we take a foot as our unit of length, and the total pressure on the surface immersed is

$$wha \text{ lb.},$$

where w is the weight in lb. of a cubic foot of water.
a is the area of the surface in square feet.
h is the depth in feet of the centre of gravity of the surface below still-water level.

For ordinary calculations in hydraulics it becomes then more convenient to take f as the water *pressure* in lb. per *square foot* instead of p the fluid pressure in lb. per *square inch*, and we shall have

$$f = 144p,$$

there being 144 square inches in a square foot.

We may now deduce a simple expression for the pressure intensity at a depth h feet in water if we suppose this incompressible, and take its weight as 62·4 lb. per cubic foot.

The pressure f on an area of 1 square foot at a depth of h feet below still-water level equals the weight of a column of water of h cubic feet; that is,

$$f = 62{\cdot}4h \text{ lb.}$$

But,

$$f = 144p,$$

so that

$$62{\cdot}4h = 144p,$$

or

$$h = \frac{144}{62{\cdot}4}p;$$

hence

$$h = 2{\cdot}3p.$$

In the form

$$p = \frac{h}{2{\cdot}3},$$

this expression means that the pressure p at a depth h feet in still water is $\frac{h}{2{\cdot}3}$ lb. per square inch; and for every h feet difference of level in water the change in pressure is $\frac{h}{2{\cdot}3}$ lb. per square inch.

EXAMPLE 3.—Find the pressure-intensity at 33·81 feet below still-water level.

Answer: The pressure-intensity

$$p = \frac{h}{2{\cdot}3}$$

is in this case

$$p = \frac{33{\cdot}81}{2{\cdot}3}$$

or

$$p = 14{\cdot}7 \text{ lb. per square inch} = \text{one atmosphere.}$$

In descending a depth of about 34 feet in still water the pressure increases one atmosphere.

EXAMPLE 4.—What is the pressure-intensity at a point 2 miles deep in a fresh-water lake?

Here

$$2 \text{ miles} = 2 \times 5280 \text{ feet},$$

and

$$\text{pressure } p = \frac{2 \times 5280}{2{\cdot}3} = 4591{\cdot}3 \text{ lb. per square inch},$$

or

$$\text{Pressure} = 312{\cdot}3 \text{ atmospheres. } \textit{Answer.}$$

When liquids differing in weight per unit volume are poured into a U-tube, the liquids will be found to stand at different heights in the two limbs of the tube in order to produce the same pressure-intensity at the surface of junction.

Suppose we take two liquids such as gasoline or light oil and water, which do not mix, and pour them into the two limbs of the bent tube, Fig. 10. After a short time the liquids will come to rest in

the tubes, and the surface of junction at A becomes clearly defined; whilst the oil stands in the left limb to a height h, reckoned from the place where the surfaces join, and the water in the other limb only stands to a height h above the same level. Clearly the pressure-intensity in the two liquids is the same at their surface of junction when the liquids are in equilibrium. Hence the column of water of height h' is of the same weight as the column of oil of height h which it supports.

The weight of the column of water above A B is $w'h'a$; where w' is the weight of unit volume of the water.
The weight of the column of oil above A B is wha; where w is the weight of unit volume of the oil.

When the liquids are in equilibrium, these two columns balance each other:

$$wha = w'h'a$$

or

$$wh = w'h'$$

hence

$$\frac{h}{h'} = \frac{w'}{w}$$

In other words, the heights of the columns are inversely proportional to the weights of the liquids per unit volume, or as their specific gravities.

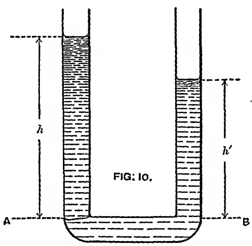


FIG: 10.

Thus it will be found by experiment that with light petroleum spirit and water

$$\frac{\text{weight of oil}}{\text{weight of water}} = \frac{7\cdot50 \text{ inches}}{10 \text{ inches}}.$$

In fact, we find that the specific gravity of the petroleum spirit is ·750 as compared with the standard substance, water.

A gallon of water weighs 10 lb., and therefore a gallon of this oil will only weigh 8 lb.

In the same way when we compare water and mercury, we find that a column of mercury one inch in height supports a column of water 13·596 inches in height, reckoned above the place where the surfaces join, hence we have

$$\frac{\text{weight of mercury}}{\text{weight of water}} = \frac{13\cdot596}{1}.$$

Mercury is 13·596 times heavier than water, bulk for bulk.

Obviously the pressure-intensity, being equal to wh, is irrespective of the width of the tubes used, so long as these tubes are not less than a quarter of an inch in diameter of bore, because then the surface action comes into play, and seriously affects the accuracy of the results.

Thus liquids such as oil and water, which *wet* glass are *drawn up* above their proper height in very narrow tubes; whilst liquids like mercury, that do *not wet* glass, are drawn down or *depressed* below the level at which they would stand in wider tubes.

The top of the water-column is seen to be *concave*, standing higher around the glass tube which it touches than in the centre of the column; whereas the mercury column stands highest in the centre of the tube, is *convex* in shape at the top, and does not wet the glass. The convex or concave surface of the liquid in a narrow tube is usually denoted by the name *meniscus*, from the Greek word (μηνίσκος) meaning *crescent*.

Very narrow tubes are said to be *capillary* (*capillus*, a hair).

In capillary tubes, then, the meniscus is *concave* and *elevated* for water, whilst it is *convex* and *depressed* for mercury. The amount of this capillary elevation or depression, that is, the *mean height to which the liquid column is raised or depressed, is found by experiment to be inversely proportional to the diameter of the tube*, according to the *law of diameters*.

In fact, experiment shows that when two fluids, such as water and mercury, are in contact with each other and do not mix, the thin film separating them is in a state of tension like an *elastic skin* stretched in all directions. To this surface-action or force, called *surface-tension*, is due the spherical form of the rain-drop and of the soap-bubble in contact with the air. Mercury or *quick-silver* has doubtless received the latter name from its tendency to form into exceedingly small spherical drops like little elastic balls when spilt or scattered on a level surface, owing to the surface-tension between the liquid mercury and air. The mercury sticks together by the force of cohesion even when a spherical drop is flattened between two glass

plates, and recovers its spherical form like an elastic ball when the plates are removed.

An ordinary soap-bubble is formed by dipping a clay tobacco-pipe in some soapsuds made of soap and glycerine, and blowing into the mouth-piece end of the pipe. The elastic film of soapsuds produced presses on the air inside, and the contractile force or surface-tension may be measured by the work done in producing a film of given area against this pull per unit area.

CHEMISTRY.—IX.

[*Continued from p. 260.*]

PHOSPHORUS—ITS OXIDES—PHOSPHORIC ACID—BORON—BORACIC ACID—BORAX—SILICON—SILICA—ATOMICITY OR VALENCY.

Phosphorus (P), atomic weight 31.—This element does not occur in nature in the free state, but it is found as phosphates of calcium, iron, aluminium, etc. As calcium phosphate, $Ca_3(PO_4)_2$, it forms the stiffening material of bones, and when they are burnt is left behind as a white ash (bone ash). Phosphorus also occurs in the brain in various complicated compounds, and in small quantities in the yolks of eggs.

Phosphorus is usually prepared from bone ash, which consists largely of calcium phosphate. The bone ash is first mixed with sulphuric acid. Calcium sulphate and a solution of phosphoric acid (containing some calcium salt) are formed; this solution is mixed with charcoal powder; the mixture is dried, and then distilled in clay retorts; carbon monoxide escapes, and the phosphorus vapour which distils over is condensed under water.

Phosphorus, when purified, is a pale wax-like solid, which is insoluble in water, but easily dissolves in carbon bisulphide. It takes fire about 45° Cent., and is therefore always kept under water. Large pieces should invariably be cut under water. When heated in air or oxygen, phosphorus burns with a luminous flame, forming white clouds of phosphoric oxide (P_2O_5); the temperature of the flame is, however, not high, and is insufficient to light a splinter of wood unless tipped with sulphur. When the vapour from phosphorus is inhaled for any length of time, a painful and disfiguring decay of the jawbone often ensues. If ordinary phosphorus be heated in a vessel, containing no oxygen, to about 240° Cent. for some hours, it is converted into an allotropic modification—red or amorphous phosphorus. Amorphous phosphorus is a brick-red powder; it is not poisonous; it is insoluble in carbon bisulphide; and does not take fire until heated to 240° Cent.; while ordinary phosphorus is a wax-like solid, very poisonous, soluble in carbon bisulphide, and takes fire at 45° Cent.

The specific gravity of phosphorus vapour is 62 ($H = 1$); its molecular weight is therefore $62 \times 2 = 124$; and as its atomic weight is known to be 31, the molecule must contain $\frac{124}{31} = 4$ atoms (P_4).

Phosphorus is chiefly used for tipping the heads of lucifer matches, and a small quantity as a vermin poison.

Phosphoretted Hydrogen, Hydrogen Phosphide, or Phosphine (PH_3).—This colourless gas can be obtained by heating some fragments of phosphorus with a solution of caustic potash in a glass retort—

$$\underbrace{3KHO}_{\text{Potassium hydrate, or Caustic potash.}} + P_4 + 3H_2O = PH_3 + \underbrace{3KH_2PO_2}_{\text{Potassium hypophosphite.}}$$

The experiment must be conducted with great care, as the gas which is evolved bursts into flame directly it comes into contact with the air. The air must therefore be removed from the retort before the mixture is heated. The most convenient method of effecting this is to fit a cork and glass tube into the tubulure of the retort, as shown in Fig. 35. The glass tube is connected with the gas supply; on opening the tap, the coal-gas passes in and gradually displaces all the air; as soon as this is effected, the supply of coal-gas is cut off and the retort heated; the neck of the retort dips under the water in the pneumatic trough; as the hydrogen phosphide is evolved, it escapes in bubbles, and each bubble, as it rises to the surface, lights, forming most beautiful smoke-rings. When sufficient hydrogen phosphide has been evolved, the heating is discontinued, and the coal-gas again turned on so as to drive out the remaining hydrogen phosphide; the retort can then be disconnected without danger. This property of lighting spontaneously in the air is due to the presence of a small quantity of an impurity. This can be proved by passing the hydrogen phosphide through a U tube,

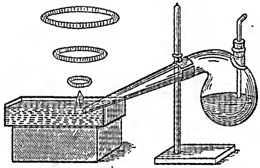


Fig. 35.

immersed in a mixture of ice and salt (which produces a temperature of about —18° Cent., *see* Fig. 36). After passing through this cold U tube the gas no longer lights spontaneously, and the U tube will be found to contain a small quantity of colourless inflammable liquid (P_2H_4) which gave to the ordinary gas (PH_3) its spontaneous inflammability. Pure hydrogen phosphide can be prepared by heating phosphorus with a solution of caustic potash in alcohol. The pure gas is colourless, not spontaneously inflammable, having an unpleasant odour of rotten fish; it lights at 100° Cent.; it is not very soluble, and is poisonous. When water is added, with suitable precautions, to a mixture of phosphorus and iodine, a crystalline substance—phosphonium iodide (PH_4I)—is obtained; when this is treated with caustic potash, pure hydrogen phosphide is evolved—

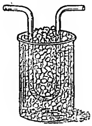


Fig. 36.

$$PH_4I + KHO = PH_3 + KI + H_2O.$$

This reaction can be compared with the reaction on p. 129, by which ammonia was prepared from ammonium chloride.

Phosphorus when burnt in oxygen or in a plentiful supply of air, forms phosphorus pentoxide or phosphoric anhydride (P_2O_5); in a limited supply of air it forms phosphorous anhydride or phosphorus trioxide (P_4O_6), a white powder which, dissolved in water, forms phosphorous acid (H_3PO_3).

Phosphorus Pentoxide is a white crystalline solid which absorbs water with great energy, and so it is termed hygroscopic. When dissolved in much water, it forms phosphoric acid (H_3PO_4).

Phosphoric Acid (H_3PO_4) occurs as a syrupy liquid or an ice-like solid—glacial phosphoric acid. It has three atoms of hydrogen in the molecule, which can be replaced by a metal to form salts, and so is termed a tribasic acid. It forms three varieties of salts—two acid and one neutral. The ordinary phosphate of soda (HNa_2PO_4) is by definition an acid salt—*i.e.*, all the hydrogen of the acid has not been replaced by a metal—yet its solution will be found alkaline to litmus paper. Ordinary phosphoric acid is made by adding about 10 per cent. of sulphuric acid to bone ash, when much calcium sulphate is precipitated, the liquid is filtered through linen, and evaporated. To the concentrated solution an excess of sulphuric acid is added, and thus all the calcium is precipitated as calcium sulphate. The clear liquid is evaporated to dryness, and the residue heated to drive off the sulphuric acid.

Phosphoric acid can also be prepared by boiling phosphorus with strong nitric acid.

When ordinary phosphoric acid (H_3PO_4)—sometimes called orthophosphoric acid—is heated to 200° Cent., it loses water, and forms a new acid, pyrophosphoric acid ($H_4P_2O_7$)—

$$2H_3PO_4 = H_4P_2O_7 + H_2O.$$

If this substance be heated to a red heat, it forms a third acid, metaphosphoric acid (HPO_3)—

$$H_4P_2O_7 = 2HPO_3 + H_2O.$$

All these acids form salts; the orthophosphates give a yellow precipitate with silver nitrate solution; the pyro- and metaphosphates give white precipitates. Metaphosphoric acid is distinguished by the fact that it coagulates a solution of white of egg.

One of the most important phosphates is bone ash, or calcium phosphate, $Ca_3(PO_4)_2$. It is largely used for the manufacture of phosphorus and of "soluble bone phosphate," the so-called "superphosphate of lime," $H_4Ca(PO_4)_2$, which is so much used as a manure. This substance is made from bone ash, or from an impure calcium phosphate known as "coprolite," by mixing the powdered phosphate with about one-third of its weight of water, and pouring on about one-half of its weight of commercial sulphuric acid. The whole is then thoroughly mixed, and allowed to stand for some time—

$$Ca_3(PO_4)_2 + 2H_2SO_4 = H_4Ca(PO_4)_2 + 2CaSO_4.$$

Nitrogen, phosphorus, arsenic, and antimony form a natural group of elements. They all form with hydrogen colourless gases having pronounced odours—NH_3, PH_3, AsH_3, SbH_3; and their oxides all form acids.

Boron (B), atomic weight, 11.—This element exists in two allotropic forms—as an amorphous brown powder, and as shining black scales, which are almost as hard as the diamond. Boron is a very insoluble substance; it is one of the few elements which combine directly with nitrogen, forming a nitride (BN). The most important compound of boron is *boric* or *boracic acid* (H_3BO_3). This substance occurs in certain small lakes or lagoons in Tuscany, in which region it issues from the earth in steam jets, and the steam when condensed forms a weak solution of boracic acid (Fig. 37); this is evaporated down, and the boracic acid obtained as soft, shining, six-sided plates. Boracic acid, when held in the flame of a spirit lamp or Bunsen burner, colours it green. A solution of this acid turns blue litmus paper a faint red, and turmeric paper brown. It has marked antiseptic properties, and has been used to preserve fish, milk,

etc. It forms salts, which are called borates; the most important being *Borax* ($Na_2B_4O_7 + 10H_2O$). This substance is found in large quantities in the "borax lake" in California, and is also prepared by neutralising the boracic acid obtained in Tuscany

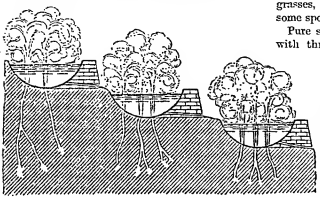


Fig. 37.

with sodium carbonate, and evaporating. Borax possesses antiseptic properties; a small quantity dissolved in milk considerably delays the period at which it turns sour. When heated, borax swells up considerably (intumesces), and finally fuses into a colourless glass-like bead. Fused borax has the power of dissolving many metallic oxides, and so it is used largely in braizing pieces of brass, iron, steel, silver, gold, and copper together. Some of the metallic oxides when dissolved in fused borax give coloured beads.

Boron forms several other compounds—the hydride (BH_3), chloride (BCl_3), fluoride (BF_3), etc., which have no special interest.

Silicon.—In several respects this element resembles carbon. Both elements occur in three allotropic forms, and form compounds having similar formulæ, as:—CO_2, SiO_2; CH_4, SiH_4 (silicon hydride); CCl_4, $SiCl_4$; CS_2, SiS_2; $CHCl_3$ (chloroform), and $SiHCl_3$ (silicon chloroform), etc. Silicon is, next to oxygen, the most frequently occurring constituent of the earth's crust; and while carbon is the element which is contained most largely in organic substances, silicon may be regarded as the chief constituent of the inorganic world.

Amorphous silicon is a brown powder insoluble in water and the ordinary acids. It dissolves in hydrofluoric acid (HF), and in a strong solution of potassium hydrate. When heated in air or in carbon dioxide, it burns, forming silica (SiO_2).

A graphitic variety and an adamantine variety have also been prepared.

Silica, Silicon Dioxide (SiO_2).—This substance occurs very largely in the earth both free—as quartz or rock crystal, often crystallised in six-sided prisms (*see* Fig. 38), amethyst, chalcedony, agate, jasper, opal, flint, sand, sandstone, which all consist essentially of SiO_2—and combined to form numerous silicates. Silica is also found in the stems of most grasses, bamboos, etc.; it forms the skeletons of some sponges, diatoms, etc.

Pure silica can be prepared by fusing fine sand with three to four times its weight of sodium carbonate in a platinum dish until all effervescence ceases; the fused mass is boiled with water, when a solution of silicate of soda ("soluble glass") is obtained. This solution is poured off from the impurities (oxides of iron, aluminium, etc.), and hydrochloric acid is added until the fluid is acid; the whole is then evaporated to dryness, and the residue made red-hot, when the silica is left mixed with salt. The silica is first boiled with strong hydrochloric acid, and then thoroughly washed and dried, when it is obtained as a fine white powder.

Pure silica cannot be fused in any ordinary furnace, but it melts in the oxy-hydrogen jet, and can then be drawn into exceedingly fine threads. Silica is insoluble in water and in the ordinary acids; it can be dissolved in hydrofluoric acid (HF), and to some extent in strong solutions of potassium and sodium hydrates. It occurs in solution in the geyser springs in Iceland, and in certain springs in New Zealand and America.

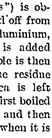


Fig. 38.

The hydrate of silicon—$Si(HO)_4$ or H_4SiO_4—is an acid, and forms an extensive and somewhat complicated series of salts—the silicates—many of which are found in nature. They are mostly insoluble in water. One of the most important is clay, a silicate of aluminium ($Al_2Si_2O_7 + 2H_2O$).

Helium (He), atomic weight, 4·4.—This element was discovered a few years ago by Prof. Ramsay, who found that it was evolved when certain rare minerals were heated. It is interesting in many respects, notably owing to the fact that it is identical with an element which had been long known to be present in the atmosphere of the sun. Like argon, it appears to be a monatomic gas, *i.e.* its molecule consists of but one atom; like argon also it is very inert. It possesses the low density of 2·2, being, after hydrogen, the lightest gas known.

We have now completed our account of the non-metallic elements; and before proceeding to an account of the metals, it will be well to devote a short space to an important property of the elements, which has not hitherto been mentioned.

This is known as the *atomicity*, or atom-fixing power, and sometimes as the *valency*, or chemical value or worth of an element, the unit being one atom of hydrogen. If we write down the formulæ of the various compounds of the non-metals with hydrogen, we find that some—like chlorine, bromine, etc.—are capable of holding but one atom of hydrogen, as in HCl, HBr, etc.; others, as oxygen, hold two atoms of hydrogen, as H_2O; others, like boron, three, BH_3; carbon, four, as CH_4, and so on. Those elements which hold only one atom of hydrogen are termed monovalent, or monads; those which hold two, divalent, or dyads; three, trivalent, or triads; four, tetravalent, or tetrades; five, pentavalent, or pentads; six, hexvalent, or hexads. Some elements, as calcium, are not known to form any compound with hydrogen, but the oxide has the formula CaO; and as oxygen is known to be a dyad, we class calcium with the dyads. The valency of some elements varies, and it seems to depend to some extent upon the elements with which they are combined; thus, sulphur is not known to combine with more than two atoms of hydrogen, H_2S, and so, as far as hydrogen is concerned, sulphur is a dyad, but it is known to form two oxides, SO_2 and SO_3. In the first it is united with two atoms of oxygen; and as two atoms of oxygen are equivalent to four atoms of hydrogen. sulphur in SO_2 is a tetrad; so in SO_3 sulphur is obviously a hexad. Again, carbon in CO is a dyad; in CO_2 a tetrad. A pentad may become a triad, and a triad a monad. It is hence evident that the valency is not a fixed quantity, and it was commonly thought that though this is the case yet the valency must be either always odd, or always even; for example, nitrogen may be a triad or a pentad, sulphur a dyad, tetrad, or hexad, etc. Nitric oxide, however, undoubtedly possesses the formula NO, that is, contains a triad united with a dyad, and this is by no means a solitary example, as the more we know regarding the *molecular* formulæ of compounds, the more numerous do such cases become. Thus ferric chloride has the formula $FeCl_3$, but ferrous chloride $FeCl_2$, while copper, which is usually a dyad, must be regarded as a monad in cuprous chloride, as it has been recently proved that the formula of this compound is CuCl, not Cu_2Cl_2, as usually written. Numerous other examples of this variable valency could be adduced.

We append a list giving the valency of some of the elements in their more important compounds; also a table giving the basicity of the more common acids (*i.e.*, the number of atoms of replaceable hydrogen which they contain). These two tables will be found extremely useful to beginners in constructing formulæ. Thus, supposing we require the formula of calcium chloride. Calcium is seen to be a dyad, while hydrochloric acid is a monobasic acid. As calcium is equal to two of hydrogen, the formula will be $CaCl_2$; take calcium phosphate, phosphoric acid (H_3PO_4) is a tribasic acid, and two molecules will contain six of hydrogen, which will be exactly replaced by three atoms of dyad calcium, $Ca_3(PO_4)_2$.

Valency or Atomicity of the Elements.

Monovalent or Monads = 1 of H.	Dyads = 2H.		Triads = 3H.	Tetrads = 4H.	Pentads = 5H.	Hexads = 6H.
Hydrogen	Oxygen	Lead	Gold	Carbon	Nitrogen	Sulphur
Chlorine	Barium	Mercury	Bismuth	Silicon	Phosphorus	Chromium
Bromine	Strontium	(Sulphur	Boron	Iron	Arsenic	Manganese
Iodine	Calcium	Carbon	(Nitrogen	Aluminium	Antimony	
Fluorine	Magnesium	Chromium	Phosphorus	Tin		
Potassium	Zinc	Manganese	Arsenic	Platinum		
Sodium	Cadmium	Iron	Antimony)	(Sulphur		
Lithium	Copper	Tin)		Chromium		
Silver				Manganese)		

When an element is placed within brackets it indicates that it may have a higher atomicity.

Basicity of the more Common Acids.

Monobasic.		Dibasic.		Tribasic.	Tetrabasic.	Hexbasic.
HCl	HNO_2	H_2S	$H_2C_2O_4$ (Oxalic Acid)	H_3BO_3	H_4SiO_4	$H_6Fe_2Cy_{12}$ (Hydroferricyanic Acid)
HBr	HNO_3	H_2SO_3	$H_2C_4H_4O_6$ (Tartaric Acid)	H_3PO_4	$H_4FeC_6N_6$ (Hydroferrocyanic Acid)	
HI	$HClO_3$	H_2SO_4		H_3AsO_3 (Arsenious Acid)		
HF	$HC_2H_3O_2$ (Acetic Acid)	H_2CrO_4		H_3AsO_4 (Arsenic Acid)		
HCN		H_2CO_3				
HClO						

LATIN.—XXIV.

[Continued from p. 264.]

ORATIO OBLIQUA (continued).

§ 29. A few usages which to some extent violate the rules laid down above must be noticed :—

(1) *Dum* is found with the present tense of the indicative. (*Vide* § 25. ii., where we noted that this special construction of *dum* is kept even in subordinate sentences in *Oratio Obliqua*.)

(2) *Relative sentences* are found in the *infinitive*, especially if they are short, and are really equivalent to a new sentence co-ordinated with the principal sentence by one of the conjunctions *et*, *nam*, etc., in accordance with the common Latin usage referred to in § 9 *supra*: *e.g.*, "'Mox veniet,' inquit, 'Caesar, qui decem tantum millia passuum abest,'" would ordinarily be expressed in *Oratio Obliqua*, in accordance with the rules laid down above, as follows: "Dixit mox venturum esse Caesarem, qui decem tantum millia passuum abesset." But the relative clause might admit of the accusative and infinitive construction of the principal sentence; that is, we might write "quem . . . abesse."

N.B.—It is not well that the student should imitate this construction, but he should carefully notice it as an example of one of the most interesting phenomena of language—the influence of one construction on another closely connected with it: and in Latin, in particular, the influence of the mood of the verb in the principal clause on the moods of the verbs in the subordinate clauses.

(3) *Conditional sentences in Oratio Obliqua.* The subjunctive in the apodosis is represented in *Oratio Obliqua* as follows:—

Present subjunctive active = future participle with *esse*.
Imperf. and plpf. " " = " " " *fuisse*.
Present subjunctive passive = *fore ut* . . .
Imperf. and plpf. " " = *futurum fuisse ut* . . .

§ 30. Just as the primary tenses in subordinate sentences of *Oratio Recta* are regularly changed to secondary tenses in *Oratio Obliqua*, so all adverbs of time and place suffer a corresponding change: *e.g.*, *nunc* becomes *tunc*, *hic* becomes *ibi* or *illic*.

It is less easy to define exactly the usage of the pronouns. It must be remembered that *se* and *suus* refer to the subject of the sentence. When used in subordinate sentences they generally refer to the subject of the principal sentence. In *Oratio Obliqua* they generally refer to the speaker whose words are being reported, as he is the subject of the sentence (*e.g.*, *dixit*), on which the whole depends. But they may also be required to refer to the subject of some subordinate verb, and in such cases *ipse* is used specially of the speaker, in contrast with *suus* of the others. Again, on the contrary, *ipse* may be used to emphasise the subject of a subordinate verb, and show that *suus* or *se* refers to that subject: *e.g.*—

Oratio Recta. Te moneo ne $\left\{\begin{matrix}\text{mihi}\\\text{tibi}\end{matrix}\right\}$ noceas.

Oratio Obliqua. (Dixit) se eum monere ne sibi noceret.

But it is doubtful to whom *sibi* refers. If it stood alone, it would naturally refer to the subject of *monere*, and so would represent *mihi* of *Oratio Recta*. In order to represent *tibi* of *Oratio Recta*, *ipse* must be added (*ne sibi ipse noceret*), as, indeed, it might well have been expressed in *Oratio Recta*.

The usage of the other pronouns *is* and *ille* corresponds to the usual difference between them: *ille* being used of the more emphatic person, *is* of the less emphatic. (They have to represent also *hic* and *iste* of *Oratio Recta*.)

§ 31. Following these rules, let the student first take the following Latin speeches, reported in *Oratio Recta*, and express them in *Oratio Obliqua*, introduced by "*dixit* . . .":—

(*a*) Juvenem flagrantem cupidine regni ad exercitus misistis. Aluistis ergo hoc incendium quo nunc ardetis. Saguntum vestri circumsedent exercitus, unde arcentur foedere: mox Carthaginem circumsedebunt Romanae legiones, ducibus eisdem diis, per quos priore bello se sunt ulti. Utrum hostem an vos an fortunam utriusque populi ignoratis? Legatos imperator vester in castra non admisit; jus gentium sustulit; hi tamen ad nos venerunt: ut publica fraus absit, auctorem culpae deposcunt. Quo lenius agunt, eo, cum coeperint, vereor, ne perseverantius saeviant. Aegates insulas ante oculos proponite, quae terra marique passi sitis. Nec puer hic dux erat, sed pater ipse Hamilcar, Mars alter, ut isti volunt . . . Saganti ruinae (falsus utinam vates sim) nostris capitibus incident, susceptumque cum Saguntinis bellum habendum cum Romanis est. Dedemus ergo Hannibalem? rogabit aliquis. Scio meam levem esse in eo auctoritatem; sed et Hamilcarem eo periisse laetatus sum, quod, si ille viveret, bellum jam haberemus cum Romanis, et hunc juvenem tanquam furiam facemque hujus belli odi ac detestor; nec dedendum solum ad piaculum rupti foederis, sed, si nemo deposcat, ablegandum eo, unde nec ad nos nomen famaque ejus accidere neque ille sollicitare quietae civitatis statum possit.

(*b*) Res omnis mihi tecum est. Dicam aperte. Si te mecum dicendo ac diluendis criminibus in hac causa contendere putarem, ego quoque in accusando operam consumerem.

§ 32. Next, let him express the following speeches, reported in *Oratio Obliqua*, in the very words of the speakers—*i.e.*, in *Oratio Recta*:—

(*a*) Senatum obtestari, ne Romanum cum Saguntino suscitarent bellum; monuisse, praedixisse se, ne Hamilcaris progeniem ad exercitum mitterent; non manes, non stirpem ejus conquiescere viri, nec unquam, donec sanguinis nominisque Barcini quisquam supersit, quietura Romana foedera.

(*b*) Haec tamen dicere: venisse invitos; ejectos domo; si suam gratiam Romani velint, posse eis utiles esse amicos; vel sibi agros attribuant, vel patiantur eos tenere quos armis possederint: sese unis Suevis concedere, quibus ne di quidem immortales pares esse possint: reliquum quidem in terris esse neminem, quem non superare possint.

(*c*) Tempus tum adesse, ut hostem vincerent, sibique ipsis gloriam, quam victi nuper amisissent, iterum recuperarent. Suo quisque duci libenter pareret, et signa impavidus sequatur.

(*d*) Dixit habere milites quam petiissent facultatem: hostem impedito atque iniquo loco tenere: imperatorem adesse existimarent.

(*e*) Militi quidem armato quid invium aut inexsuperabile esse? Saguntum ut caperetur, quid periculi, quid laboris exhaustum esse? Romam, caput orbis terrarum, petentibus quicquam adeo asperum atque arduum videri, quod inceptum moretur? Cepisse quondam Gallos ea, quae adiri posse Poenus desperet; proinde aut cederent animo atque virtute genti per eos dies toties ab se victae, aut itineris finem sperent campum interjacentem Tiberi ac moenibus Romanis.

§ 33. After the practice you have had in expressing *Oratio Recta* in *Oratio Obliqua*, and *vice versâ*, there need be little difficulty in rightly rendering the exercise given in § 34 into Latin.

It must be remembered that the only way English has of marking *Oratio Obliqua* is by the change of time and person. The English use of a past tense throughout makes great care in translation necessary. Latin, as we have seen, has a similar usage in all subordinate clauses, but not also (as English has) in principal clauses. English, thus, presents many pitfalls to the unwary.

The only really effective safeguard against mistakes on this count is to think in each instance what was the tense which the speaker used himself; that is, we must first mentally retranslate our *Obliqua* back into *Recta*, and so find out the very words of the person whose speech is to be reported in *Obliqua*.

The utmost care is also needed in order to distinguish clearly the different persons to whom the English pronouns refer, and to translate them by the right Latin equivalent (*v.* § 30).

§ 34. Before attempting to translate this passage, the student should carefully read the notes appended to it:—

To none of them did the victory seem[1] greater and more complete than to the general[2] himself. He was transported[1] with delight at the thought[3] that he had won a victory with the very branch of the army with which his colleague had been defeated. It had brought back the courage of the soldiers, and revived their spirits, and there was no one except his colleague in command who wished the struggle to be deferred. He was more disabled in mind than in body, and it was the recollection of his wound that made him shrink from a battle and its bullets.[2] But they must not lose their energy along with him. To what purpose was further delay, or loss of opportunity? Were they waiting for a third general, and another army? The French camp was pitched in Italy, almost in sight of the Eternal City itself. It was not now Sicily and Sardinia that were being attacked, but they were being driven from the land of their fathers, the country of their birth. "What lamentation there would be," he cried,[4] "among our ancestors, who used to wage war round the very walls of the enemy's capital, if they could see us, their descendants—two generals and two full armies—cowering in terror inside our camp in the middle of Italy, and the French masters of the whole country between the Alps and the Apennines!" Accordingly, disregarding the opposition of his disabled colleague, he ordered[1] the soldiers to prepare for an immediate battle.

NOTES ON FOREGOING PASSAGE.

[1] In historical narration, for the sake of greater vividness, the *present* indicative ("historic present") is often used instead of the past tenses. Another very common and idiomatic construction is the present infinitive ("historic infinitive"), which is similarly used (where in English we require a past tense of the indicative), without any change in the rest of the sentence.

[2] In translating one language into another, we must, as we have noticed, aim above all at expressing ourselves in terms consistent with the modes of thought and the manners of the people whose language we are using. We shall constantly find that there is no exact equivalent in Latin for the English idea, and in such cases we must aim at expressing the nearest corresponding idea that we can discover.

Thus, the Romans had, of course, no bullets like ours, though they did have appliances of various kinds (v. in Dictionary, under *machina, tormentum, ballista, catapulta*) for hurling masses of stone and arrows, and other missiles. We may sometimes find that we can get the nearest Latin equivalent for such offensive and destructive weapons of war by using one of these expressions: but they would answer rather to "cannon" and "cannon-balls" and "shells" than to "bullets." Arrows would more closely represent the notion; but a still more exact equivalent will be found in the *pilum* or *telum*, which was flung from a distance, and often followed up by a charge in which the sword especially was used (*cf.* the modern bayonet-charge).

Again, the natural generals of a Roman army in the days of the republic were the consuls, and a "consular" army was one composed of the normal number of legions completely equipped. We shall get more Latin colour in our prose if we make use of facts like these.

[3] *At the thought that* . . . All that follows from this point to the concluding sentence is in *Oratio Obliqua*, whether it expresses the consul's thoughts or his actual utterances, and may be idiomatically rendered in Latin as directly dependent on the verb expressing his delight, out of which may easily be understood "for he said that" or "thought that" (*cf.* § 4). It is quite usual to have *Oratio Obliqua* introduced in Latin by no more definite expression.

[4] Such a return as this to the speaker's actual words (*Oratio Recta*), which is very common in a report of a speech in English, is also found in Latin authors, introduced by the proper verb of saying; but it will be better here to continue the *Oratio Obliqua* construction to the end (*vide* further notes to next exercise).

KEY TO EXERCISES.

p. 260.

A philosopho, si afferat eloquentiam, non asperner, si non habeat, non flagitem. Si mihi probabis ea quae dices libenter tibi assentiar. Si ea sola voluptas esset, quae ad sensus cum suavitate afflueret, ut ita dicam, nulla corporis pars vacuitate doloris sine jucundo motu voluptatis contenta esse posset. Sin autem, summa voluptas est, ut Epicuro placet, nihil dolere, primum tibi recte concessum est, nihil desiderare manum, cum ita esset affecta. Si vita doloribus referta maxime fugienda est, summum profecto malum est vivere cum dolore. Epicurus autem, "Virtutem," inquit, "nisi voluptatem efficeret, quis expetendam arbitraretur?" Id profecto non fecissent, si nihil ad se pertinere arbitrarentur. Si amici mei desiderio me moveri negem, certe mentiar. Id si ita est, ut optimi cujusque animus in morte facillime evolet tamquam e custodia vinclisque corporis, cui censemus cursum ad deos faciliorem fuisse quam Scipioni? Nunquam tale voluisset, sed si voluisset paruissem. Si in templum faces ferre vellet, sibi faciendum putaret. Difficile est amicitiam manere, si a virtute defeceris. Si sapientiam meam admirari soletis—quae utinam opinione vestra digna esset—in hoc sumus sapientes, quod naturam optimam ducem tamquam deum sequimur eique paremus. Gratissimum nobis feceris, si hoc ante dixeris. Faciam vero, praesertim si utrique vestrum, ut dicis, gratum futurum est. Nisi tu id amisisses, numquam ego recepissem. Si verum esset id, omnem spem quasi deleret. Eundem esse credite, etiam si nullum videbitis. Quod ni ita se haberet, nemo ad victoriae gloriam niteretur.

p. 261.

Quamquam est nobis subito ereptus, vivit tamen mea memoria semperque vivet. Quamvis sit audax, id facere non audeat. Milites, quamquam magnis itineribus fessi erant, pugnam flagitabant. Quamvis sapiens sis, tamen eum non vinces. Quamvis subito id facias, non imprudentem eum occupabis. Quamquam non ad finem venit inceptum, tamen laude summa dignum est. Licet moriar, tamen hoc dicam. Ita se gessit quasi demens esset. Contra quam sperabam fecit. Aeque nocens re vera est ac si omnium calamitatum causa nobis fuisset. Perinde ac si patrem tuum necavisset, poenas persolvet. Ita valde eram perturbatus, tamquam si in ipsam civilis discordiae flammam incidissem. Nulla umquam in vita mea voluptate tanta sum affectus, quanta afficior hac integritate, nec me tam fama, quamvis summa sit, quam res ipsa delectat. Non minus nostra sunt quae animo complectimur quam quae oculis intuemur; neque tibi amicior, quam ego sum, quisquam succedere posset. Cum rem omnino aliter institutam offendissem ac mihi placuisset, si adfuissem, tamen ea quae pollicitus eram feci. Sic habeto, non tibi majori esse curae quam mihi, ut iste tuus a me discessus quam fructuosissimus tibi sit.

TRANSLATION OF VERGIL.—I. (p. 262).

I sing of arms and that hero, who first, an exile by destiny, came from Troy's shores to Italy and the Latin coast. Much tossed was he both on lands and on sea, by force of the powers above, by reason of the ever mindful wrath of cruel Juno. Many things, too, did he suffer in war, while he founded a city and brought his gods to Latium; from whom comes the Latin race and the Alban fathers and the walls of lofty Rome.

Call to my mind, oh Muse, the causes—for what hurt to her divinity, with what source of grief the queen of the gods drove a man, so noted for his piety, to turn the wheel of so many misfortunes, to undertake so many labours. Have heavenly minds such deep wrath?

There was a city of old (settlers from Tyre held it), Carthage, at a great distance opposite to Italy and the Tiber's mouth—rich it was in power and very fierce in war's pursuits. In this one city Juno is said to have dwelt more than in all (other) lands, Samos holding a lower place. Here were her arms, here her chariot; that this should be the empire of the world, if only the Fates would allow it, was the cherished purpose of the goddess. But she had heard that a race was rising from Trojan blood, which should one day overturn the Tyrian towers; hence should come a people king over broad lands and proud in war to the ruin of Libya: so the Fates guided events. In fear of this, the daughter of Saturn, mindful of the war in old days, which she first had waged at Troy for her dear Argos (nor yet had the causes of her wrath and her fierce pangs gone from her mind; stored deep in her soul there lingered the judgment of Paris and the wrong to her slighted beauty, and the race she hated, and the honours paid to ravished Ganymede). Fired with rage for these things, she was keeping far from Latium the Trojans, the relics left by the Greeks and cruel Achilles, tossed over all the sea; and through many years they were wandering, driven by the Fates, round all the seas. So great a task was it to found the Roman race.

HISTORIC SKETCHES, GENERAL—IV.

(*Continued from p. 270*).

THE MOSLEMS IN EUROPE.

It was a momentous issue that was decided on the last day of that seven days' battle between the Saracenic host and the army of European Christians under Charles the Hammer (so called from the way in which he smote the enemy on this occasion), which was fought on the banks of the Loire, at the spot where now stands the city of Tours, on October 10, A.D. 732.

The question at issue really was whether or not the dominion of the Saracens, who had already conquered so far and so thoroughly, should be extended to northern and western Europe, and whether Christianity should be subverted by the religion of Mahomet, whose intolerant disciples and zealous proselytisers the Arabian Saracens were. To the cries of "Death or the Koran!" "There is but one God, and Mahomet is the prophet of God!"—cries which were the knell of hundreds of thousands of Christians—the Saracens burst from their desert home in Arabia, and swept in one strong tide of conquest through northern Africa, western Asia, and eastern Europe, till they paused on the Morocco shores of the Mediterranean Sea. They looked northward; they were full of energy and restlessness, and they thought to gratify their ambition and to spread the religion of their prophet by further conquests on the continent of Europe. While in this frame of mind a renegade Christian knight, Count Julian, displeased with the treatment he had received from his master, the Gothic King of Spain, invited the strangers to invade his master's kingdom. Under the conduct of Tarik (whose name is preserved in that of the rock of Gibraltar, called by the Saracens *Gibel-al-Tarik*), a resolute band crossed the straits, landed in Spain, and, assisted by reinforcements of their countrymen, conquered the country, and reduced the Christians to a condition of dependence, if not of slavery. As soon as they had settled their new gain into something like order, they looked round for fresh conquests, and marching across the Pyrenees, pushed on as far as the Loire, overcoming the very slight resistance that was opposed to them. Their plans included the conquest of France, Italy, and Germany, the seizure and dismemberment of the Greek empire being reserved as a sort of *bonne-bouche* for the last. The effect of this would have been, in all human probability, to drive Christianity into the cold regions of the extreme north, where the remnants left of the European nations would have found a home, secure by virtue of its climate from the attacks of the cold-dreading sons of Arabia. There seems, however, to be a rule of nature that the south shall not prevail over the north, but contrariwise, that in the long run the north shall be master. So it proved at the battle of Tours in 732. Though the accounts we have of the battle, and of the circumstances attendant upon it, are chiefly from Christian writers, whose record bears upon the face of it strong marks of exaggeration, especially in point of numbers, the Saracen host being computed at near half a million of men, we may yet gather that the contending hosts were vast, considering the populations which furnished them, and also we may believe that the Christians were in the minority. For seven days the fight lasted; scarcely was night allowed to break the continuance of the fray; the cross and the crescent struggled for the mastery, and the iron-clad warriors of the Church struck hard and thrust deep against the lighter-armed Moslems, whose skill and bravery had brought so many nationalities to their feet. May we not join with the valiant and pious men who, having fought and conquered with Charles the Hammer, ascribed the victory, not to the strength of their own arms of flesh, but to the mercy of the Lord, who fought on His people's side?

Some accounts have it that 300,000 of the Saracens were slain, an almost incredible statement when we consider the gunpowderless weapons with which all the butchery must have been done; but however that may be, the Saracens were routed with such tremendous loss that they never afterwards attempted an invasion of France. Their shattered army re-crossed the mountains, and sought in the quiet of its Spanish provinces to be healed of the wounds which "so bloodily did yawn upon its face." Charlemagne, grandson of the Hammer, recovered from the Saracens a large portion even of their Spanish territory, and established a military colony in the acquired districts to serve as a bulwark to Christendom against further encroachments from the south.

But who were the Saracens, and whence came they? The answer involves some mention of the origin of the Mahometan religion. About the year of our Lord 569 there was born at Mecca one Mahomet, the son of a Christianised Jewess and her husband Abdallah, who was an idolater. Mahomet's parents died when he was a lad, and from the age of thirteen till he was more than forty he was engaged in trade, having been instructed and brought up by his uncles, Abu-Taleb and Abd-al-Motalleb. While still a young man he married Kadijah, a rich widow, old enough to be his mother, and being by the marriage placed in affluence, gave himself to contemplation and to study. Every year

he retired to a cave near Mecca in order to spend a month in solitude and prayer, and he announced that during these periods the angel Gabriel appeared to him and told him hidden things. Then he related how he had been taken by the angel into the presence of God, who had told him he was to be His prophet, that prophet which should unite all men under one religion of which the one indivisible God was head. The Koran, or "Book that ought to be read," contained the revelations which the angel Gabriel, as the mouthpiece of the Almighty, was supposed to have made to Mahomet.

The first to believe in Mahomet as the prophet of God was his wife Kadijah, whose example was followed by several of Mahomet's kinsmen and acquaintance; but the people were slow to accept him, and the authorities at Mecca were so scandalised at his professions, that after a short time spent in preaching to the people he was forced to fly to Yatreb, now Medina (the city), where he had many disciples. Medina became the nucleus of the prophet's power, and thither flocked the discontented and the converted to enrol themselves under his banner. Bands of armed men belonging to his sect infested the road to Mecca, hostilities broke out, and Mahomet succeeded, after several encounters in which fortune did not always favour him, in arranging for peace, one of the conditions of which was his public entry into Mecca in his capacity of prophet. From this time Mahomet became the most powerful prince in Arabia; converts by the thousand were made to his religion, and he began to turn his thoughts towards spreading his doctrines beyond the limits of his own country. For "the people of the book"—that is to say, people who claimed to have had special revelations, as the Jews and the Christians—he allowed his followers to have toleration on payment of tribute, but for idolaters of all kinds the message brought by Mahomet contained only a choice between the alternatives, Death or the Koran. Mahomet, beyond sending a few military missionary expeditions, under enthusiastic commanders against some of the southern provinces of the Greek empire, does not appear to have done much more than to acquire for himself and his religion a complete supremacy in Arabia. All foreign rule was abolished by him, all other religious systems were forced to yield precedence to his within the borders of Arabia, and ready to do his bidding was an army of 100,000 hardy warriors, unenervated by civilisation, and entirely possessed with the belief that it was their duty and their privilege to spread the knowledge of Mahomet and his teaching.

CHARLES MARTEL AT THE BATTLE OF TOURS.

On the 8th of June, A.D. 632, the prophet died from the effects of poison, administered, it is said, by a Jewess who wished to try whether he actually was, as he asserted himself to be, the Messiah that

should come into the world. Discord sprang up among the chiefs upon the question of a successor, but the supreme command over the faithful was at length accorded to Abubeker, the father of Ayesha, Mahomet's favourite wife. Abubeker crushed by force of arms the efforts of rivals to depose him, assumed the title of Khaliph or Vicar, and proceeded forthwith to enlarge the borders of the Saracenic empire. Making wise choice of commanders, chief of whom was the mighty Khaled, "the sword of God," he invaded Syria, Babylonia, and the nearest provinces of the Greek empire, and covered the Saracen arms with the laurels of victory. Damascus and Jerusalem were both attacked, and the former, though defended by a numerous garrison, and though the Emperor Heraclius sent an army of 100,000 men to relieve it, was captured on the very day that Abubeker died (A.D. 634). Under Omar, the successor of Abubeker, Persia, Egypt, and Syria fell, Jerusalem itself falling into the Khaliph's power in the year of our Lord 637. Upon the spot where Solomon's temple had stood, the great mosque of Omar was built; the Christians were allowed to retain their churches, and were promised protection in return for tribute, and at first it seemed as if the change of masters would prove beneficial—the change from the slothful misgovernment by provincial governors appointed by the emperor to the strong, just, and wise government of the Khaliph.

From the death of Omar, who was assassinated in 643, till the invasion of Spain in 710, the Saracen empire had extended its borders with little intermission. Besides establishing itself all along the coast of northern Africa, it had mastered the islands of Sardinia, Sicily, Rhodes, and Crete, and had effected a lodgment on the Italian peninsula. But during that time also divisions had sprung up among chiefs who each claimed the throne, and who appealed to the sword to decide between them. The Arabian simplicity and hardihood became diminished by contact with civilisation and refinement, and it was found by the middle of the eighth century that the authority of the Khaliph at Bagdad was practically set at nought, and his dominion confined to the limits of the city itself. Quasi-independent kingdoms were erected in Tunis, Tripoli, Egypt, Morocco, Damascus, and Spain, each under some successful soldier-chief, who owned only a nominal allegiance, if any, to the Commander of the Faithful at Bagdad.

This decline in power, these splittings up of the unity of the empire, were the salvation for a while of the Greek empire. They were the causes, too, coupled with the establishment of the Christian kingdoms of Leon, Castile, the Asturias, and Navarre, and the continuous bearing down from the north upon the south of the large nationalities of the German and Sclavonic families, why the Saracenic wave of conquest did not sweep northwards after it was first stemmed by Charles the Hammer at the battle of Tours.

There was another and more deadly cause for the break-up of the Saracenic power, at least in the East. In the wars which the Khaliphs waged from time to time upon the barbarous people who dwelt on their north-eastern frontier, there had been captured many stalwart men, of large frame and sturdy constitution, who were allowed their freedom from labour and from the other incidents of conquest on condition of entering the military service of their captors. These men were from Turkestan, Tartars of the roughest, strongest kind. They accepted the conditions, and they formed the household troops of the Khaliph about the time when the energetic brethren of their master were establishing themselves in their newly-gained Spanish possessions. From guards they soon learned to become masters, and to dispose of the succession when that came in question according to their own liking. The Kaliphate declined visibly. Al Radi, who died in 940, was the last of the real Khaliphs; after him there was no head of the empire, and the Turkish soldiers seized for themselves the provinces immediately surrounding the capital city of Bagdad. The title of Khaliph was, however, maintained by the Turks for some nominee of their own, in order to give them a sort of title to commit the acts of government they wished. In the year 1258 it was finally abolished, the slave-masters having by that time become sufficiently strong to dispense with assistance, and to hold their possessions by the help of their own swords.

Reinforced by large additions from Tartary, the Turks took some time to consolidate their power. They borrowed from the Saracens most of what was valuable in their system, they adopted their religion, and they imported from home certain hardy principles and practices which gave solidity and robustness to the state. Now and again they had to endure the attack of some unusually energetic Greek emperor, who led his armies from Constantinople for the purpose of winning back some of the lost ground that had been wrested from feeble governors. But not unfrequently they gained the advantage in this strife, and whether they did or not, they noted down the aggression as a thing to be paid back with interest some day. That day came when Constantinople fell before their assault; but that event did not happen for more than three centuries after the Turks had become a power in the world.

The separate kingdoms of Saracenic foundation remained *in statu quo* for long periods of years. excepting that the Sultan of Egypt assumed the lead among them, and, as it fell to pieces, absorbed such provinces of the Bagdad empire as the negligence or the impotence of the Turks suffered to drift away. It was with the Sultans of Egypt, most famous of whom was Saladin, that the Crusaders had to reckon, when they endeavoured to recover the Holy Land. Syria had fallen to Egypt, and the Sultans of Egypt protected it, succeeding, ere they in due time fell before the westward march of the Turks, in driving the Christians out of the whole of Palestine, and in rendering barren of results all the work of the Crusades.

In Spain the Saracenic, or, as it was called from its identity of interest and from its origin, the Moorish, kingdom long remained, in spite of the strenuous efforts of the Christian princes of the north to destroy it. Not until several of the small Christian states had been rolled into one, and made one in interest, one in political purpose, one as a nation, was an impression made on the kingdom of Granada, and even then the impression was, so to speak, a slight one. From indolence, incapacity, from whatever cause, the Christian princes who strove from the year 1100 downwards, with some prospect of ultimate success, to oust the Moors, proved unequal to the task. It was reserved for Ferdinand the Catholic, whose marriage with Isabella of Castile had welded into one the Christian power in Spain, to overthrow without hope of restoration the throne of the Moslem in Cordova. Many strong towns had been gradually won, the bulwarks of the kingdom had been sapped since many years, but on the 2nd of January, 1492, the Spanish king had the satisfaction of receiving as conqueror the keys of Granada, the last stronghold of the Moors.

Forty years had not elapsed since every echo in Europe had resounded to the crash of the Greek empire as its capital fell to the Turks. Fresh influxes of men, fresh leaders, new dynasties, had come to swell the might and to develop the resources of those invaders. An irrepressible ardour burned in their hearts to burst their bounds and to achieve conquests, and the weakness and the riches of the Greek empire proved an irresistible bait. With a multitudinous army, supplied with everything for the siege of the greatest city of the world—with skill, courage, and confidence in himself—Mahomet II. pitched his camp around the fated city, and carried it at last by assault. Constantinople passed into Turkish hands, by which it has been retained ever since; and for a while it was feared that the Moslem faith, which had been kept out of Europe, save Spain, would be forced upon it by the Turks. Vienna was twice besieged by the Turks, the last time in 1683; and it was but owing to victories like the naval one of Lepanto in 1571, to those in which the king and people of Hungary so frequently sacrificed themselves, and to heroic efforts like those which enabled John Sobieski, King of Poland, to rescue Vienna in 1683, that the Turkish power was kept from encroaching further westward in Europe.

See:—Cassell's Universal History; Cassell's Russo-Turkish Wa'

ELECTRICITY.—III.

[*Continued from p. 278.*]

THE METALS AS FUELS—THE VOLTAIC CELL—CHEMICAL ACTION IN A CELL—LOCAL ACTION—THE ALIMENT—POLARISATION—THE E.M.F. AND RESISTANCE OF A CELL—BATTERIES.

THE fact that a current is flowing through any substance implies that there is some source where energy is being expended in order to maintain that current. If the current is generated by a dynamo driven by a steam engine, the place where the energy is being expended is the furnace. Coal contains a large store of energy, which it gives off when burnt, in the form of heat; this heat, after undergoing various changes, finally takes the form of the electric current which flows through the conductor, and which may be there utilised for lighting, etc. The coal is the fuel, or source of supply; and it is the oxidation or burning-up of this coal that supplies the necessary energy for the generation of the electric current. A given weight of coal contains a perfectly definite amount of energy, which it gives up in the form of heat during the process of being burnt.

In any Voltaic cell there must always be some substance which has stored up in it a supply of energy; when the cell is working, this substance must be undergoing some process by which it gives up sufficient energy to maintain the current. The process which the substance undergoes in order to generate an electric current is exactly similar to that which the coal undergoes in order to generate heat. In both cases the substance is oxidised, or burnt up, and energy is given off; in the case of coal the energy takes the form of heat, in the case of the other substance the energy takes the form of the electric current. A cell is nothing more nor less than a little furnace in which some substance is consumed, and in which the energy thus evolved takes the form of the electric current instead of heat.

A given weight of any substance, when burnt in

a furnace, gives off a fixed quantity of heat; and the same weight of that substance, if consumed in a cell, gives off a fixed amount of current. If we know the amount of heat that any substance can give off when burning, we know the amount of current that it can give off when consumed in a cell. The more heat a substance will give off when burnt in a furnace, the more current will it supply when consumed in a cell. A knowledge, therefore, of the quantities of heat given off by different substances when burning, acts as an unfailing guide to the best substances to use as the fuels in a cell. The following list contains the amount of heat—in calories—given off in uniting with oxygen, by a weight of each substance which is electro-chemically equivalent to one gramme of hydrogen.

A calorie is the amount of heat required to raise the temperature of one gramme of water from 0° *to* 1° *Centigrade.*

HEAT VALUES OF SUBSTANCES.

Substance.	Heat Value.	Substance.	Heat Value.
Potassium - - -	69,800	Platinum - - -	7,500
Sodium - - - -	67,800	Carbon - - - -	2,000
Zinc - - - - -	42,700	Oxygen - - - -	0
Iron - - - - -	34,120	Nitric acid - - -	—6,000
Hydrogen - - -	34,000	Oxide of manganese - -	—6,500
Lead - - - - -	25,100	Peroxide of lead -	—12,150
Copper - - - -	18,700	Ozone - - - - -	—14,800
Silver - - - - -	9,000		

An inspection of this list shows that potassium is the best substance to use as the fuel in a cell, but there are two insurmountable objections to its use—it is too expensive, and its tendency to unite with oxygen is so great that, when placed in an oxidising liquid, it unites so quickly with the oxygen that sufficient heat is given off to make it take fire. This metal cannot, therefore, be used in a cell, though it is quite possible that some alloy of it might behave in a more manageable manner. Sodium is open to the same objection. Zinc is the substance that stands next highest on the list, and zinc is the substance that is almost always used as the fuel in a cell. That zinc is a fuel in the ordinary sense of the word may be seen by performing the following experiment:—Take a very thin sheet of zinc, cut it into narrow strips, and hold the end of a bundle of these strips in a hot flame; the bundle will at once take fire, burning with a bright blue flame, and giving out more heat than would be given out by its equivalent of coal.

THE VOLTAIC CELL.

If a plate of pure zinc be immersed in a jar containing dilute sulphuric acid, no action of any kind takes place between them, though the zinc is a fuel and the sulphuric acid is an oxidising liquid. (It may here be remarked that pure zinc is a substance not easily obtained; that which is sold as such in shops is very far from being pure.) If a plate of copper be now immersed in the same liquid, but without touching the zinc, no action will yet take place; both metals remain unacted upon by the liquid, and neither heat nor current is generated. If, however, the metals are connected by a conducting-wire outside the liquid (as shown in Fig. 2), the original state of affairs is completely

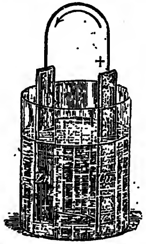


Fig 2.—ZINC AND COPPER ELEMENT.

changed; the sulphuric acid oxidises or burns up a portion of the zinc; an electric current is generated, but the copper plate remains unacted upon. The current starts at the surface of the zinc, flows through the liquid to the copper, up the copper plate, and back to the zinc through the conducting-wire. This course is indicated by the arrows, the zinc plate being marked *Zn*, and the copper *Cu*.

Reference to the above table shows that both zinc and copper are fuels, and therefore that they both tend to oxidise and to drive currents through the circuit in opposite directions; but as two currents cannot flow through a circuit in opposite directions at the same time, it is clear that only one current can flow, and that this current will be generated by the consumption of that substance which is the better fuel—that is to say, by that substance which has the higher heat value. Zinc, therefore, is the substance from which the current starts, and zinc is the substance which is burnt up in order to supply the energy necessary for the maintenance of the current; for this reason the zinc is called the **positive element**, and the copper—which plays no further part than that of acting as a conductor for the current out of the cell—is called the

negative element. In every cell that substance which acts as the fuel is the positive element.

The terms *positive and negative poles* must not be confused with positive and negative elements. The *positive pole* is that part or terminal by which the current leaves the cell; in the cell which we have been considering it is clearly the upper portion of the copper plate; the *negative pole* is that part or terminal through which the current returns to the cell, and is the upper part of the zinc. *In every cell the positive pole is the upper part of the negative element, and the negative pole is the upper part of the positive element.*

The amount of current that can be got by the consumption of a given weight of zinc in a cell is a perfectly definite quantity. We saw in lesson I. that 1 ampere flowing for 1 second deposited 0·005199 grains of zinc, and, conversely, the consumption of 0·005199 grains of zinc in any cell will generate a current of 1 ampere for a period of 1 second. By no combination of circumstances is it possible to get more current than this for the given consumption of zinc, and it is therefore possible at all times to calculate the length of time that a current can be maintained by the consumption of a given weight of zinc, or, what is of more practical importance, the weight of zinc that will be consumed in maintaining a given strength of current for a given time.

EXAMPLE.—A cell gives an average strength of current of 1·5 amperes for a period of 3 hours; how much zinc will be consumed in the cell?

The amount consumed in 1 second is clearly

$$1·5 \times 0·005199 \text{ grains.}$$

And this must be multiplied by the time—in seconds—during which the current has been flowing; thus—

$$1·5 \times 0·005199 \times 60 \times 60 \times 3$$
$$= 84·24 \text{ grains.} \qquad \textit{Answer.}$$

This is the weight of pure zinc that would be consumed in the cell provided all the energy given out by the zinc took the form of useful current; but in practice this is never the case; there are always some sources of loss, as will presently be pointed out, which necessitate the consumption of a somewhat larger amount of zinc than is indicated in the above example.

CHEMICAL ACTION IN A CELL.

Provided the zinc is pure, no chemical action takes place in the cell till the metals are placed in contact, or are connected by a conducting substance outside the liquid. This operation is technically called "completing the circuit." The reason of this passive condition of the zinc can be understood if we consider that the zinc cannot be consumed—under the given conditions—without giving out its energy in the form of current. The whole surface of the zinc which is immersed tends to unite with the acid, and to be burnt up by it; but in order that this action shall take place, it is necessary that a current shall start from every particle of zinc which is being consumed.

From whatever place a current starts, it must of necessity return by some path to the same place; otherwise the current cannot exist. In the case of the cell, the current starts, or tends to start, from the whole surface of the immersed zinc at the same instant, and with the same force. Clearly, then, the current cannot return to the place from which it started through the liquid; and unless some path is available by which it can return to the zinc outside the liquid, no current can exist. Unless, therefore, the circuit is completed, as shown in Fig. 2, outside the liquid, no chemical action takes place in the cell.

The instant the circuit is completed outside the liquid, the sulphuric acid attacks and consumes the zinc. Sulphuric acid is composed of three substances—hydrogen, sulphur, and oxygen, in the proportion of

2 parts of hydrogen,
1 part of sulphur,
4 parts of oxygen,

and is usually denoted by the symbols H_2SO_4, where the letters H, S, and O stand for hydrogen, sulphur, and oxygen, and the numbers 2 and 4 beneath the letters H and O show the number of parts of hydrogen and oxygen contained in a molecule of the acid. The chemical symbol for zinc is *Zn*. When zinc becomes oxidised or burnt up by sulphuric acid, the acid changes its composition. It will be seen, on reference to the above table, that zinc has a higher heat value than hydrogen, and any oxidising substance will for this reason unite with zinc in preference to hydrogen; even if the oxidising substance is already in combination with hydrogen, it will separate itself from it and unite with the zinc, thus setting the hydrogen free. This is exactly what does occur in the Voltaic cell when a current is flowing:—The substance SO_4 is an oxidising substance, and it is in combination with hydrogen to form sulphuric acid, H_2SO_4. The instant the current starts, the sulphuric acid, which is in contact with the zinc, parts with its two particles of hydrogen and unites with one particle of zinc; the hydrogen thus set free bubbles up through the acid in the form of gas and mingles with the atmosphere; a small portion of it, however, adheres to the surface of the copper plate, and plays a most important part—as we shall presently see—in the action of the cell. The SO_4 unites with the zinc

and forms a new substance, called sulphate of zinc, having the composition of

1 part of zinc (Zn),
1 „ sulphur (S),
4 parts of oxygen (O).

This sulphate of zinc is heavier than sulphuric acid, and consequently sinks to the bottom of the cell, thus allowing fresh portions of the acid to take its place, and to maintain the constant consumption of the zinc. The copper plays no part in the action of the cell; it is simply a necessary adjunct for leading the current out of the liquid. The reaction which takes place in the cell may be expressed in chemical language thus—

$$\underbrace{Zn}_{\text{Zinc.}} + \underbrace{H_2SO_4}_{\text{Sulphuric Acid.}} = \underbrace{ZnSO_4}_{\text{Sulphate of Zinc.}} + \underbrace{H_2}_{\text{Hydrogen.}},$$

or zinc and sulphuric acid unite to form sulphate of zinc, and hydrogen is set free.

LOCAL ACTION.

A piece of chemically pure zinc is not attacked when immersed in dilute sulphuric acid, because there is no path along which a current could return to its starting point; in the case of ordinary commercial zinc, this state of affairs is completely changed. Commercial zinc contains as impurities small quantities of iron, arsenic, pieces of coke, etc., and when any one of these substances is at the surface of the zinc, and therefore in contact with the acid, all the necessary conditions for the generation and maintenance of an electric current exist. The zinc is attacked by the acid, and the current generated flows in eddies through the liquid and into the foreign substance, through which it returns to the zinc. All the zinc in the vicinity of such a foreign particle is attacked and quickly consumed, the acid is converted into sulphate of zinc, and hydrogen bubbles are freely evolved and rise through the liquid. This phenomenon is known as local action; its existence can always be detected by the zinc giving off gas when the cell is not supposed to be sending any current; it may even be caused by inequalities in the texture of the zinc itself.

A familiar though not generally recognised example of local action may be seen in old iron railings. It will often be noticed that the iron gets eaten away close to the ground, and not unfrequently in the case of very old railings they get broken off at this part. This is partly due to oxidation and partly to local action. These railings are usually fixed in position by having their ends placed loosely in holes cut in the stone, and having the vacant space round them filled up with melted lead. Iron and lead are thus in contact, and the presence of a little acid is all that is now necessary in order that local action may commence. There is always a little acid brought down by the rain, and this immediately starts the action. Reference to the table shows that iron has a higher heat value than lead, and therefore iron is the substance which acts as the fuel and gets eaten away by slow and continual action. This can be prevented by keeping the junction of the metals free from the acidulated moisture by covering it with paint, or by fixing the railings in position in the first instance with cement, or some such substance, instead of lead.

Where commercial zinc is used as the fuel in a cell, local action can always be prevented by having its surface thoroughly amalgamated—that is to say, by covering it with a coating of mercury. The process of amalgamating the zinc is very simple: first dip the zinc in dilute sulphuric acid so as to thoroughly clean it, and then either dip it in mercury or rub mercury over it with a rag. The mercury immediately adheres to the zinc and forms a bright-looking pasty amalgam of zinc and mercury on its surface. This amalgam completely covers any impurities that may exist in the zinc, and local action cannot therefore take place as long as these impurities are covered. The mercury plays no part in the action of the cell, which now works as if pure zinc formed the fuel. As the zinc in the amalgam gets consumed during the process of generating a current, the mercury forms a fresh amalgam, and thus preserves a fresh surface of pure zinc. A still better plan is to mix about 4 per cent. of mercury with the zinc during the process of casting.

THE ALIMENT.

In any cell which is sending a current through a circuit, the action will continue till one of two things happens—till all the zinc gets consumed, or till the oxidising agent with which the zinc is uniting gets exhausted; in the cell with which we have been dealing, this means that all the sulphuric acid has been converted into sulphate of zinc, or, as it is said, the acid is *killed*. During this operation, the action of the cell, which was brisk at the beginning, has gradually become weaker and weaker as the acid was being converted into sulphate of zinc, and during the latter stages of the operation the action of the cell was feeble in the extreme; all action ceased when the zinc was no longer in contact with a substance with which it tended to unite.

Let us compare this action of the cell with the burning of an ordinary fire. The fire will go out when one of two things happens: when the coal has all been consumed, or when *the supply of air is*

exhausted. Under ordinary circumstances, the supply of air is unlimited. but take the case in which the fire is lighted in a room which is hermetically sealed: the fire will burn brightly at first owing to the supply of oxygen being sufficient, but as the air becomes used up, the action of the fire becomes feebler and feebler, till it finally ceases to burn when the air is exhausted, or when the coal is no longer in contact with a substance with which it tends to unite. Clearly, then, the air plays the same part to the coal in the burning of a fire as the sulphuric acid does to the zinc in the cell. In the following lessons that substance which unites with the fuel will be spoken of as the aliment.

The action of the fire as well as the cell depends upon the nature of the aliment. If pure oxygen be supplied to a fire instead of air, the fire will burn more actively. and this effect might be still further augmented by supplying it with chlorine gas; in the case of the bell, its action would be increased by replacing the sulphuric acid by bichromate or permanganate of potash, or by any more strongly oxidising agent than the acid. In any cell the amount of aliment as well as the amount of fuel is necessarily a fixed quantity, and the cell will cease to work as soon as either of them gets used up.

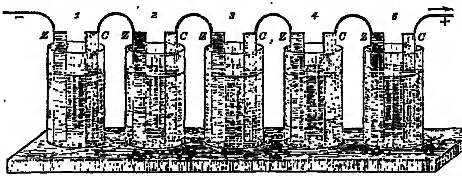


Fig. 3.—Cells connected in Series.

POLARISATION.

When speaking of the chemical actions in a cell, it was explained how hydrogen gas was given off freely whenever the cell sent a current. This hydrogen plays a most important part in the action of the cell; it is given off at all parts on the surface of the copper plate, which quickly becomes completely covered with a film of hydrogen bubbles, after which any further bubbles that are evolved rise through liquid. At the same time that the copper plate is becoming covered with hydrogen it will be noticed that the E.M.F. of the cell is falling, and when the plate has become completely covered, the E.M.F. has attained a permanent value which is only about one-third of that which it originally possessed. The explanation of the phenomenon is obvious: the plate when covered with hydrogen no longer acts as if it consisted of copper; hydrogen is the substance which is in contact with the liquid, and for this reason the plate behaves as if it were composed not of copper. but of hydrogen.

The E.M.F. of a cell depends upon the difference between the heat values of the substances immersed in the aliment: the greater this difference the greater is the E.M.F. of the cell. Reference to the table shows that this difference for zinc and copper is 23,940 and for zinc and hydrogen 8,700; the difference in the latter case is but little more than one-third that of the former, and the E.M.F. of the zinc and copper cell must therefore fall to one-third of its original value as soon as the copper plate has become covered with hydrogen. The deposition of hydrogen on the negative element is known as **polarisation**, and the plate which thus becomes covered is said to be ***polarised***.

It does not in the least matter what substance is used as the negative element provided it has a lower heat value than hydrogen. We may use lead, silver, platinum, carbon, etc., as the negative element, and in each case we will get a different E.M.F. when the cell first starts working—the E.M.F. will be proportional to the difference between the heat values of zinc and the metal used—but as soon as the plate has become polarised, the resulting E.M.F. will in every case be exactly the same.

The hydrogen bubbles have another deleterious effect on the working of the cell; gas is an extremely bad conductor of electricity, and the layer of hydrogen bubbles through which the current must flow introduces a high resistance into the path of the current.

THE E.M.F. AND RESISTANCE OF A CELL.

The E.M.F. of a cell depends entirely upon the

nature of the substances of which it is composed, and is quite independent of the size of these substances. Two cells if made up of the same materials will have exactly the same E.M.Fs., notwithstanding the fact that one of them may be a hundred times as large as the other.

The resistance of a cell depends upon the substances of which it is composed, and upon the size and arrangement of those substances. The better they are as conductors, the lower will be the resistance of the cell; the greater the area of the plates, the lower the resistance of the cell; and the closer the plates are together, the more will the resistance of the cell be diminished. The principal part of the resistance of any cell is to be found in the aliment, and in the film of hydrogen if the cell is polarised; the plates, as a rule, offer but a negligible resistance.

BATTERIES.

It is not always that a single cell is sufficient to send the required current through a given resistance. In such a case a number of cells are used, and are joined up as shown in Fig. 3. Such a collection of cells is called a *battery*. Here five cells are shown connected up in series, which means that the copper of the first cell is connected to the zinc of the second, the copper of the second to the zinc of the third, and so on; the last copper at one end and the last zinc at the other end form respectively the positive and negative poles of the battery, and are marked + and —. The coppers are all marked C and the zinc Z, whilst the arrows show the direction of the current through the cells.

When cells are joined up in series as is here shown, it is evident that *the same current must flow through all*, and therefore the same amount of zinc must be consumed in each cell. In order, then, to find the total amount of zinc consumed in a battery, we can find the amount consumed in a single cell as above indicated, and multiplying this amount by the number of cells in series in the battery gives the total amount consumed.

ENGLISH.—XXIV.

[*Continued from p.* 297.]

PHONETICS (*continued*).

By this time the distinction between voiced and voiceless sounds ought to be abundantly clear, and we can go on to deal with the next step in our work of classifying speech sounds. We proposed above to follow the breath in its passage from the lungs outwards, and to notify any interruption it met with that would give rise to a differentiation of sound. If we kept literally to this programme we ought next to deal with the differentiation caused by the uvula. But as nasal sounds are in English comparatively unimportant, it will be more convenient to defer their consideration for the present and to explain first that important distinction which we have already had occasion to refer to, namely, the distinction between vowels and consonants.

This distinction, it will be found, depends finally on whether the mouth and its appurtenances, the tongue, teeth, and lips, are in such positions that the breath in passing them is subject to friction or interruption so as to make a distinct sound. This statement will be made more intelligible by experiment. Take the sounds represented by *a* in *father* and *v* in *vertical*. They are both voiced sounds, that is to say, the glottis is closed and the vocal chords vibrate in each case. But with *a* the mouth is wide open and the breath issues freely; with *v*, the mouth is so closed that the breath cannot issue without making a buzzing noise. Similarly compare *ee* in *feel* with *z* in *zebra*. In this case not only are both sounds voiced, but the mouth is open to about the same extent for each sound, and yet they are totally different. The difference is that with *ee* the breath issues freely, with *z* the tongue is so placed as to obstruct the passing breath, and thus create a distinct sound. Lastly, compare the *oo* in *boot* with the *b* in the same word. Both sounds are voiced and both require a protrusion of the lips for their proper formation. But in the case of *oo*, when the lips have been placed in the proper position for the formation of the sound, they are left open and the breath passes through without obstruction. In the case of *b*, on the contrary, while the breath is passing out, the lips are sharply drawn together and sharply separated so as to produce a distinct explosive sound.

The student will see that we have now arrived at a physiological explanation of the familiar distinction between vowels and consonants. In the case of a vowel the breath passes freely through the mouth, in the case of a consonant the passage of the breath is *audibly interrupted*. This distinction is so important that it is necessary to test it in every possible way. So far we have only experimented with voiced sounds, for the simple reason that the vowel of ordinary speech, as its name, *vocalis*, implies, is always voiced. But if we speak in a whisper we can, as already explained above, pronounce a sound like that of a loud vowel without allowing the vocal chords to vibrate. Let the reader do this. Let him pronounce in as loud a whisper as he can the various sounds represented by the italicised letters in the following words: f*a*ther, f*a*te, f*ee*l, f*i*le, f*oa*l, f*oo*l, f*a*ll, f*ow*l. He will find that he can distinguish between these sounds perfectly though

his vocal chords are silent the whole time. In other words he has produced *whispered vowels*. Now let him compare these whispered vowels with the ordinary voiceless consonants, for example, with *f*, *s*, and *p*, just as we compared the ordinary vowels with the ordinary voiced consonants, *v*, *z*, and *b*. He will find that the consonant *f* and whispered *ee* are both voiceless, that is, the vocal chords in neither case vibrate. But in the latter case the breath escapes freely and the sound produced is due simply to the resonance of the cavity of the mouth; in the case of *f* the teeth and lips together make an audible interruption to the passage of the breath. The same thing is true of whispered *ee* and *s* or of whispered *oo* and *p*, or of any whispered vowel or any voiceless consonant.

By these various experiments we have now sufficiently established the truth of the statement with which we started: that the distinction between a consonant and a vowel is caused by the breath being so interrupted in the former case by the parts of the mouth as to produce an audible noise, whereas in the latter case it is allowed to escape freely into the air. Or to state the same proposition another way, as it was first admirably expressed by Wheatstone in 1837:—"The vowels are formed by the voice, modified, but not interrupted, by the various positions of the tongue and lips." Taking this then as the definition of a vowel, let us now proceed to examine by what means the numerous vowel sounds with which we are familiar are differentiated from one another.

Since "voice" is a common element in all the vowels of ordinary loud speech, it is obvious that the difference between one vowel and another must be due to the modifications which the breath undergoes in its passage through the mouth. The general nature of these modifications can best be realised by comparing the cavity of the mouth to a tube of an organ. In an organ, the sounds produced are due to the vibrations of the air passed through the different pipes. When a key is struck, the tube with which it communicates is at once filled with a vibrating column of air. This vibrating column gives rise to a "note" which varies both in pitch and quality with the shape of the tube. It is, perhaps, well to explain parenthetically that by the term "quality" as applied to a note is meant that characteristic which distinguishes the note of one musical instrument from a note of the same pitch on any other musical instrument, say the note of a piano from that of a fiddle. The cavity of the human mouth then may be looked upon as an adjustable organ-pipe, but it has this advantage over the artificial instrument, that the sounds it produces can be made to vary not only in pitch and quality, but also in "kind." Thus a man may sometimes "pitch" his voice high and sometimes low, and we are able to recognise different speakers by the "quality" of their voices. But in addition to this a human being, whether speaking high or low, gruffly or clearly, can always produce at will different kinds of sound, that is to say he can always mark the differences between the sounds which we represent in writing by *a*, *e*, *i*, etc.

We have just claimed this power as a special attribute of the human organs of speech, but as a matter of fact it is possible by means of a properly-constructed organ-tube, or arrangement of tubes, to reproduce the principal vowel sounds employed in human speech. More than fifty years ago two German professors experimented with tubes for producing vowel sounds, and their experiments were repeated with success and further developed by an English professor at the University of Cambridge. These experiments, however, led to no practical results, and did not indeed contribute anything of much value to phonetic science.

The point then at which we have now arrived is this, that the mouth when uttering a vowel acts like the pipe of an organ, and that the nature of the vowel is due to the shape of the pipe. If, indeed, we neglect the sound caused by the vibration of the vocal chords—as we can in the case of the whispered vowel—we may say that the distinctive vowel sound is entirely due to the vibration of the column of air in the pipe formed by the mouth, cheeks, tongue, and teeth. Hence, in order to classify the different vowel sounds, we must proceed to examine the different methods by which the mouth-pipe—if we may so call it—can be modified.

The first method which will occur to everyone is the alteration of the position of the tongue. By placing the tongue in different positions we can clearly alter completely the shape of the cavity of the mouth. The number of possible positions for the tongue is of course infinite, but our ears are only sensitive enough to catch broad variations of sound, so that there is no advantage in enumerating more than a limited number of positions.

THE SHAPE OF THE TONGUE.

How many positions it is desirable to recognise we will discuss presently, but first it must be pointed out that the mouth-cavity can also be altered by changing the *shape* of the tongue. Thus the tongue can be either spread out flat, or tightened up so as to be peaked and narrow. This difference in shape leads to a perceptible difference in sound, though the *position* of the tongue may be unaltered. The difference is, however, a delicate one, and the student may have some trouble with it at first.

THE ACTION OF THE CHEEKS.

There is, however, another method of altering the mouth-cavity which cannot be mistaken. If the cheeks are drawn in or the lips drawn down at the corners, the cavity of the mouth is "rounded," and a very marked character of sound results. For example, compare the sound of *oo* in *fool* with that of *u* in *but*. As we shall see presently, the tongue-position in each case is the same and the tongue-shape is the same, but in the one case the mouth cavity is rounded by the action of the cheeks and the lips, in the other case it is flat.

There are other methods by which the formation of vowel sounds in the cavity of the mouth can be modified, but they do not as a rule lead to distinctive differences, so that we need only occupy ourselves with the three methods just described. They are: 1st, Altering the position of the tongue with reference to the palate or teeth; 2nd, Altering the shape of the tongue; 3rd, Rounding the mouth-cavity. Of these three methods the first is by far the most important from the much greater variety of results obtainable. In fact, as has just been said, we recognise only two shapes of the tongue, wide and narrow, and only two shapes of the mouth-cavity, round and flat, but we have not yet decided how many positions of the tongue it is possible and necessary to recognise.

The best way to determine this question is to take the familiar vowel sounds of our own language —which, by the way, is extremely rich in vowels— and observe how many distinct positions of the tongue are required to produce them. This process, it might be thought, would only lead us to a very insufficient scale, for it would only embrace English sounds. But, as will be seen presently, though we propose to appeal to English sounds only in order to show how our scale ought to be built up, the scale itself when complete will be found to be sufficiently capacious to embrace foreign sounds as well. The only reason in fact for appealing first to English sounds is because they are the most familiar to probably all the readers of these lessons.

WHAT IS A VOWEL?

But before we can apply this process, we must be quite sure that we are agreed as to what a vowel is. If, for example, I were to ask my readers to name an English vowel, it is more than probable that most of them would reply by naming the first letter of the alphabet. But *a*, that is the *a* that occurs in *name*, is *not* a vowel, or at any rate not a pure vowel. It is a diphthong. That is to say the sound represented by *a* in *name* is composed of two distinct vowel elements, each of which is separately recognisable and each of which requires distinct arrangement of the vocal organs for its formation. It would therefore be useless to appeal to the double sound *a* to guide us in forming a scale of simple vowel sounds.

What then are the simple vowel sounds of the English language? This question must be answered gradually. First of all take the following well-known words, *bat, bet, bit, but, hot, foot*, and pronounce them aloud. Next cut off from each of them the initial consonant and pronounce the remaining combinations again aloud, *at, et, it, ut, ot, ŏŏt*. Now comes the difficulty, but it can easily be got over with a little trouble. Try and gradually drop the final *t* in each case so that nothing but the vowel sound is heard. This must be done very carefully, so that the student does really pronounce the right vowel with absolute correctness when he has omitted the consonant. In order to make sure, he ought to go over the process several times, first saying *at, et, it, ut, ot, ŏŏt*, and then pronouncing the corresponding vowels without the final *t*. After some pains the student will find that he can pronounce with perfect ease the short vowels *a, e, i, u, o, ŏŏ*, so that the pure vowel sound and nothing else is heard.

THE POSITIONS OF THE TONGUE.

As soon as he can do this let him notice what is happening to his tongue. He will feel that sometimes it is high up in his mouth, sometimes low down, at one time right forward, at another drawn back. It will be a good plan for him to perform these experiments in front of a looking-glass, so that as far as possible he may actually see the successive positions of the tongue. Let us deal first with the three vowels *at, et, it*. The position of the tongue can be clearly seen when forming each of these. With all of them it is right forward in the mouth, but with *at* it is low down, with *et* it is a little higher, with *it* it is higher still, right up to the roof of the mouth. Thus we see that we can detect at least three well-marked positions of the tongue according to its height in the mouth.

But it is obviously insufficient to consider the height only of the tongue. Its nearness to the front or to the back of the mouth must clearly also affect the sound produced. Take for instance the two vowels in *at* and *ut*. In the one case we feel the tongue right forward in the mouth, in the other it is a long way back. What we have then to do is to determine how many positions of the tongue according to its forwardness or backwardness we ought to recognise. Will two be sufficient? Or can we, as before, in the case of the height of the tongue, detect three well marked positions?

To answer this question, take the three words *bud, bird, bared*, and pronounce the last two as they are

invariably pronounced in southern England, without any trilling of the *r*. Then, as before, separate the vowel sounds from the consonants, and pronounce each vowel sound clearly by itself—*r*. *err*. *air*. The first of these, namely the vowel in *bud*, is of course identical with the vowel in *but* that the student has already learnt to pronounce. The word *bud* is only quoted in order to facilitate comparison with *bird* and *bared*. But the sounds *err* and *air* are by no means so simple. To begin with, they are both double sounds. The sound *err* is indeed only a prolongation or a duplication of the simple sound *er*, which we want to catch. But the sound *air*, as generally pronounced, consists of two elements, the first is the characteristic one, the second is a glide very much like *er*. So that if we wrote the two words our in full we should have to spell them in some such way as this: *e(r)er*, *ai(r)er*. There is a further difficulty with these two sounds. For the *er* sound is little more than an emphasised form of "voice" which was described sufficiently above. It is on this account we may mention parenthetically that the *er* vowel is so common in the English language. It is the easiest vowel to make, and thus we allow so many previously distinct vowels to glide into it, butt*er*, doct*or*, Flor*a*, lab*our*, *heard*, *girl*, *word*, *curd*, *her*.

Both these difficulties can, however, be got over. Instead of pronouncing the sounds in *bud*, *bird*, *bared* aloud, whisper them. By doing this "voice" is eliminated, and thus we can be sure that we have got hold of the vowels themselves. But this is not all. We must get the first element in each of the sounds *err* and *air* separate from the second. There is no more difficulty in doing this than there was in pronouncing the vowels in *at*, *et*, *it* without the following *t*. Assuming then that the student has succeeded in doing this, let him now whisper these three vowel sounds in succession, that is to say, pronounce them without allowing the vocal chords to vibrate. If he has been careful to catch the right sounds, he will now as he whispers them in succession feel the tongue successively advancing forward from the back of the mouth to the front. The principal difficulty, as we have already pointed out, in the way of this experiment is that *air* is generally and properly pronounced as a diphthong *ai(r)er*, so that the tongue after advancing to the front of the mouth for the initial vowel sound in *air*, goes back again to the midway position in order to add *er*. But if this can be avoided, and only the pure vowel pronounced, we get a complete horizontal scale of three tongue-positions for the three vowels *u*, *e(r)*. *ai(r)*.

THIRTY-SIX POSSIBLE VOWELS.

Thus then we have at length established three horizontal as well as three vertical positions of the tongue. It is clear therefore that there must theoretically be nine recognisable positions of the tongue. But we have already stated that apart from its position the tongue can have two shapes, narrow and wide, so we get eighteen possible vowels. Again, the cavity of the mouth may be either left in its normal condition, or may be "rounded" by the contraction of the cheeks or lips. As this process can be applied to every position and to each shape of the tongue, it follows that in theory it is possible to form thirty-six distinct vowel sounds. As a matter of fact, however, no one language contains nearly this number of vowels, and there is one very good reason why they should not all be found in the same language. It is this: that though all the thirty-six are produced by different positions of the speech organs, yet the resulting sounds are in many cases so similar that in ordinary conversation they would inevitably be confused. This statement, it will be noticed, is apparently inconsistent with the principle we have been going upon in determining our list of vowel positions, *i.e.* only to enumerate positions which lead to easily distinguishable results, as in the case of *at*, *et*, *it*. But the inconsistency is only apparent. For, as has been already explained, the distinctive sound of each vowel is due to the shape of the column of air in the mouth-cavity; and it may easily happen that the same shaped column is produced by two quite dissimilar actions of the mouth-organs. Thus, narrowing the tongue will in some cases produce almost the same effect as raising it, and hence a narrow low vowel may possibly be confused with a wide vowel of medium height.

THE ENGLISH VOWELS.

It is not, however, of so much importance to work out this rather fine point as to apply the theoretical scale of vowels to the actual vowel sounds of our own language. But before we can do this we must say a word or two in further justification of the distinctions between "wide" and "narrow" and between "round" and "open" vowels. The best way to explain these distinctions is to give cases where two different vowels are produced by the same tongue-*position* but by different tongue-*shapes* and mouth-*shapes*. Thus take the vowels in *but* and *father*. If the student pronounces these carefully, he will find that the difference between them is, that in the case of the former the tongue is narrow or heaped up; in the case of the latter the tongue is wide or flat. Just the same distinction will be found between the vowel about which we have already said so much, namely, the characteristic vowel-element in the word *air*, and the common vowel in *man*.

The distinction between "round" and "open" vowels will be more easily seen. For in the case of such vowels as *ōō* in *fool* and *aw* in *awl* it is obvious at once that the mouth is rounded, and it is equally obvious that it is not rounded for the vowel in *but*. In the same way the mouth is rounded for the vowels in *foot* and *hot*, but not for the vowel in *father*.

Having made these explanations, we are now in a position to apply the theoretical scale of vowels to the actual vowels of the English language. Here it is:—

		Narrow Tongue. Back.	Midway.	Front.	Wide Tongue. Back.	Midway.	Front.
Open Mouth.	High			feel			bit
	Mid-height	but		fail	father	fine	bet
	Low		err	air		how	bat
Rounded Mouth.	High	fool			foot		
	Mid-height	no			boy		
	Low	fall			hot		

This arrangement and analysis is due to Mr. Henry Sweet, one of the principal English authorities on Phonetics. In order to make the table intelligible, the reader must remember that the vowels referred to in the case of the diphthongs are only the initial or characteristic elements in each case. Thus the diphthong *ow* is made up of an initial vowel sound, which we will call *x* for the present, and of a glide *ōō*. It is this vowel sound *x* which according to the table is made with a "wide" tongue, and an "open" mouth, with the tongue low down in the mouth and midway between the front and back. In the same way the *i* in *fine* is some vowel which we will call *z* followed by a glide *ēē*. It is this vowel *z* to which the table refers. So with *oi* in *boy* and *ai* in *fail*.

And now, perhaps, the reader may begin to see the practical use of this table, and of the phonetic analysis we have been going through. Ill-educated people, especially in London, constantly mispronounce the diphthongs in *fine* and *how*. The first they turn into something like *foin* and the second into *heaow*. The mistake is made in each case with the initial element of the diphthong. In the same way *fail* is often mispronounced *file*. By studying the above table and practising the sounds the reader will be able to discover how these mistakes are made, and will learn how to avoid them himself, should he have the misfortune to be prone to them.

FRENCH AND GERMAN VOWELS.

In order to show the applicability of the above table to other languages, we will add here a copy of the same scale applied to the principal French and German vowels:—

F. - - G. - -			fini viel			
F. - - G. - -		que ende	été see	chat mann		dette mensch
F. - - G. - -		un	père	an		
F. - - G. - -	sou gut		lune grün	und		[en schütz.
F. - - G. - -	beau sohn		peu	on sonne	homme	schön
F. - - G. - -			veuf			

The student who is familiar with French or German will be able to use this table to test his pronunciation. It will be well, however, to warn him that the table takes no account of the *length* of vowels, but only of their quality. Thus, both the vowels in the French word *fini* are short, but they are both of the same quality as the German *viel*, or the English *feel*. That is to say, if the French *i* in *fini* were prolonged, the English *ee* would result. In the same way the vowels in *été* are short; but if we prolonged the French *é*, we should get the German *ee*; and if we added the English *ee* glide to the French *é*, we should get the English diphthong in *fail*, *rein*, etc. So again in the French *chat* and the German *mann* the vowel is of the same quality as the vowel in the English *father*, but it is pronounced more quickly in both of the foreign languages than in English. It will be noticed further that the French *sou* is the same as the English *fool*, and the German *und* as the English *foot*. Also that the French *père* rhymes with the English *air*. But in comparing the English *no* with the German *sohn* and the French *beau*, it must be remembered that the foreign sounds are pure vowels, while the English *o* sound is followed by an *oo* glide which turns it into a diphthong.

COMMERCIAL BOTANY OF THE NINETEENTH CENTURY.—XII.

[*Continued from p. 274.*]

FIBRES (*continued*).

ANOTHER substance which has come into use in comparatively recent years as a substitute for horsehair is CRIN VEGETAL, and consists of the crushed fibres

from the leaves of *Chamærops humilis*, the European Fan Palm. It is cultivated in some parts of Southern Europe and Northern Africa, particularly by French colonists in Algeria. It grows rapidly, so that almost any quantity of the leaves could be obtained. It is said that one man can cut 400 lb. of leaves per day; the extraction of the fibre, which is a very simple process, is usually done by women and children. The fibres are either dried in their natural colour, green, or dyed black to resemble horsehair, as a substitute for which in upholstery work it is chiefly used. It is exported principally to England, France, Germany, and the United States. The exact date of its introduction is not known. Large quantities of baskets are made from the dried leaves.

In the early part of 1889 a new fibre from the West Coast of Africa was brought to notice at Kew, under the name of BOLOBOLO, and is also known in the Yoraba language as AGBOURIN ILASSA. The plant furnishing this fibre proved to be *Houckenya ficifolia*, belonging to the natural order Tiliaceæ. The fibre is not an article of present import, at least under its own name. Under the name of BOMBAY ALOE FIBRE a sample of white fibre was received at the Kew Museum at the close of 1888. It proved to be obtained from *Agave vivipara*, a plant closely allied to the common American aloe. The subject is treated in the *Kew Bulletin* for 1890, page 50, and 1892, pages 36 and 283.

FODDERS.

The question of the extended cultivation of fodder plants has always occupied more or less of the attention of agriculturists.

About sixty or seventy years since several new fodder plants were brought to notice as suitable and very desirable for cultivation in England. The exact dates, however, when they were first proposed it is difficult to fix. About sixty years since a considerable amount of interest was excited in the GAMA GRASS or BUFFALO GRASS (*Tripsacum dactyloides*) of the Southern States of America. Though it is considered by some a good forage plant, it is somewhat too tender for general cultivation with us.

Aira flabellata, better known as *Dactylis cæspitosa*, the TUSSOCK GRASS, a strong-growing tufted perennial, native of the Falkland Islands, was introduced to Kew in 1842.

Under the name of *Bromus Schraderi*, a new fodder grass was introduced some twenty or thirty years ago. The plant, which is now known to botanists as *Ceratochloa unioloides*, is commonly known as AUSTRALIAN PRAIRIE GRASS. It occurs from Central America to the last alpine zone of Northern Argentina, and has spread over many parts of the globe. It is described as one of the richest of all grasses, grows continuously and spreads rapidly from seeds, particularly on fertile and somewhat humid soil. It is a very nutritious fodder and pasture grass, besides which it is said to be very valuable for sowing in coverts, as it entices hares and rabbits into the woods away from the grain crops.

Prangos pabularia, TIBET HAY.—A perennial belonging to the Umbelliferæ, forming a stem a few feet high. It is a native of Tibet, as its common name implies, where it is extensively used as a fodder for sheep, goats, and oxen. It was introduced to cultivation as a fodder plant in this country about 1840, but it did not succeed.

Perhaps the most important fodder plant introduced during this century is that which is now so well known as PRICKLY COMFREY. This was first brought to notice in 1877, and advertised as *Symphytum asperrimum*. The history and value of the plant is thus summarised in the Kew Report for 1878:—"It is apparently identical with a *Symphytum* which has long been naturalised in the neighbourhood of Bath and elsewhere, and which has been identified by botanists with *S. asperrimum*, a native of the Caucasus. Neither the naturalised nor the forage plant appear to be really identical with that species, but have been found by Mr. Baker to agree with *Symphytum peregrinum*, which appears to be not certainly known as wild anywhere, but to be probably a hybrid of garden origin between *Symphytum officinale* and *S. asperrimum*. . . . In England Prickly Comfrey has been found very useful for winter fodder, as it forms large tufts of root leaves, which start into growth early in the year and bear several cuttings; it is greedily eaten by animals which refuse ordinary comfrey, the habit and appearance of which are not very dissimilar." The acclimatisation of the plant has been attempted in various parts of the world, including India, Ceylon, Singapore, and Australia, with, however, but little success, as it is more suited for cool or temperate countries.

In 1877 a considerable amount of interest was directed to the fleshy corollas of the well-known Indian MAHWA tree (*Bassia latifolia*). The tree, which belongs to the natural order Sapotaceæ, is very common in many parts of India, especially in Bengal, and the flowers are produced in such large quantities as to cover the ground when they fall; they are succulent and sweet, somewhat like a raisin in appearance, but with a heavy cloying taste and smell. They are largely used as an article of food, both fresh and stored for winter use. In the year previously mentioned (1877) a quantity of these flowers was sent to England for trial in feeding cattle, as well as for distilling a spirit from

them. From the first they were reported most favourably upon, the flesh of pigs fed upon them was said to be especially good, while for distilling purposes they were said to have yielded as much as 6·16 gallons of proof spirit per cwt., the flavour of which was very similar to that of Irish whisky, though by careful rectification it might be made exceedingly pure and free from flavour. In India the spirit is manufactured on a large scale, and it is said that more recently the flowers have become an article of export from Bombay to France, where they are distilled, the spirit being put into French bottles, labelled as French brandy, and exported again to Bombay. As an article of import to this country, however, Mahwa flowers have not fulfilled what was anticipated of them.

TIMBERS AND HARD WOODS.

Notwithstanding all that has been done by the British possessions as well as by foreign countries to bring their forest resources prominently forward at the several International Exhibitions since 1851, the result cannot be said to be satisfactory so far as the British timber trade is concerned.

The magnificent collections of Australian timbers that have from time to time been shown, as well as those from the Cape of Good Hope, notably in the Colonial and Indian Exhibition of 1886, have not resulted, as might have been anticipated, in creating a demand for them in this country. In the case of Australasian timbers, however, there may be some reason why they have not yet figured as regular articles of import with us, and this is the cost of freight for so long a distance, coupled with the fact that most of the timbers of those far-off colonies are very dense and remarkably heavy. This is, of course, especially the case with the numerous species of *Eucalyptus*, which genus furnishes some of the most characteristic of Australian woods, and it is in these hard, tough and durable timbers of Australia that the greatest advance has been made, and this not for furniture or building purposes but for road-paving. Enormous quantities of the West Australian JARRAH (*Eucalyptus marginata*) and KARRI (*E. diversicolor*) are now brought into this country already cut into blocks of a suitable size for paving, and used in most of our large towns.

There are some other Australian woods that have appeared occasionally in our markets, and ought to be regularly known in the timber trade, if only for cutting into veneers,' should the woods be too costly to use in the solid. Of such we may mention MUSKWOOD (*Olearia argophylla*), TASMANIAN MYRTLE (*Fagus Cunninghami*), and HUON PINE (*Dacrydium Franklinii*), all of which have been greatly admired by our ornamental wood dealers, but some system of a demand on this side of the world, and a ready response on the other, seems to be needed to create a trade in these bulky commodities.

So far as woods for cabinet purposes are concerned, though fashion rules the demand in this as in everything else, there is always a sale for such well-known woods as mahogany (which has been used in this country as a cabinet wood since the middle of the last century), walnut, &c.; and in connection with this it may be worth while here to place on record what has been done in the introduction of the mahogany tree in India, Ceylon, and Mauritius, so that future generations may draw their supplies of this valuable wood from the East as well as from the West Indies. So far back as 1873 seeds were sent from Kew to India, and in 1879 the cultivation of the tree was referred to as an "accepted success." In 1890 it was reported from the Fiji Islands that 700 plants that had been raised from Kew seed, besides a large number from other sources, had been distributed over the colony, many of which had been planted out and had grown to a height of from twelve to fourteen feet. No further reports are, however, to hand regarding the progress of any of these plants. Meantime a new source of a very similar wood, under the name of African mahogany, has come into the English market in large and increasing quantities. It was first noticed in the *Kew Bulletin* for 1890, page 168, and again in 1894, page 8, and in 1895, page 79, where it was stated that the trade was first started in 1886, and has already assumed such proportions as to seriously affect the mahogany trade of Honduras and other countries, the wood even reaching America as far as Louisville and Kentucky, where it is to be bought at a much cheaper rate than the mahogany from Central America and Cuba. Though African mahogany is undoubtedly the produce of several different trees, the only one of which the scientific name is known is *Khaya Senegalensis*, which is a tree closely allied to the true mahogany.

One of the most valuable woods that has been introduced to this country within the last fifty years is SABICU, or, as it is sometimes called, SAVICU. It is the produce of *Lysiloma Sabicu*, a leguminous tree of Cuba and San Domingo, whence it is imported to this country, and latterly in small quantities also from the Bahamas. The wood is so hard, dense, and durable that it was much used at one time in ship-building for keelsons, beams, engine-bearers, stern-posts, &c. It was not much known, however, before 1851, in which year it was used for the stairs of the great Exhibition, and notwithstanding the immense traffic upon them, they

were found at the close of the exhibition to be but little the worse for wear. In 1879 Bahamas Sabicu wood was first used for weaving shuttles and bobbins, but the demand for this purpose has never been large.

Another building timber of great importance is KAURI (*Agathis australis*). This is a large tree, 100 to 150 feet high, native of the northern island of New Zealand. It is eminently suitable for doors, straight and circular mouldings, match-boarding, and other joiners' work, as well as for casks and engineers' patterns. The wood has been imported in small quantities for many years, and always meets with a ready sale. It yields a valuable resin known as KAURI GUM (*see* Resins).

Probably there is no branch of the subject relating to the supplies of wood or of its utilisation of more interest than that which touches the supply of boxwood for engraving purposes. For some years past there has been a gradual falling off in the supplies; indeed, in 1875 it was stated that the boxwood forests of Mingrelia, in the Caucasian range, were almost exhausted, and wood that had been rejected in old forests was being eagerly cut, and purchased at high prices for export to England. The cutting of wood in Abhasia and in all the Government forests in the Caucasus was prohibited, and about the same time a prohibition was issued by the Porte against the cutting of boxwood at Trebizonde. Up to the present time no wood has been discovered that at all equals box for engraving purposes, so that while other woods may be substituted for the various other uses to which box was at one time largely put, for the best engravings box alone is still in demand. In 1880 some consignments of Indian boxwood were received in the London market, but the difficulty of transit from the Himalayas, where the tree grows, operates against its becoming a regular article of export.

The increase of what is known as process work has much diminished the demand for boxwood for engraving. Nevertheless, we may quote the names of the principal woods that have been tried :—

1. *Acer saccharinum.*—SUGAR or BIRD'S EYE MAPLE. North America. Not favourably reported upon.
2. *Amelanchier canadensis.* AMERICAN SHADE or SERVICE TREE. Might prove useful.
3. *Brya ebenus.*—COCUS WOOD. Jamaica. Equals bad box.
4. *Bursaria spinosa.*—TASMANIAN BOXWOOD. Found in North, West, and South Australia, Queensland, New South Wales, Victoria, and Tasmania. Equal to common or inferior box.
5. *Carpinus Betulus.*—HORNBEAM. Britain. Not very favourably reported upon.
6. *Cornus florida.*—NORTH AMERICAN DOGWOOD. Rough, suitable only for bold work.
7. *Cratægus oxyacantha.*—HAWTHORN. Britain. By far the best wood after box.
8. *Diospyros ebenum.*—EBONY. Ceylon. Nearly as good as box in texture : colour of wood an objection.
9. *Diospyros texana.*—A North-American tree. Nearly equal to best box.
10. *Elaeodendron australe.*—Queensland and New South Wales. Suitable for diagrams, posters, etc.
11. *Euonymus Hamiltonianus.*—PAI CHA. China, where the wood is much used for carving and engraving. A useful wood, especially for bold work.
12. *Eugenia procera.* — Jamaica, Antigua, and Martinique. Suited for bold, solid newspaper work.
13. *Monotoca elliptica.*—New South Wales, Victoria, and Tasmania. Not very favourably reported upon.
14. *Pittosporum bicolor* and *P. undulatum.*—New South Wales, Victoria, and Tasmania. Both woods are suitable only for bold outlines.
15. *Pyrus communis.*—COMMON PEAR. Britain. Not very well reported upon, but it does well for engraved blocks for calico printers.
16. *Rhododendron californicum* and *R. maximum.*—Both of these have been favourably reported upon from North America.
17. *Tabebuia pentaphylla.* WEST INDIAN BOX.—West Indies and Brazil. A fairly good substitute for box.

The most recent substitute for true boxwood that has been brought to notice, and one that at first promised to become of considerable importance, is that known as Cape boxwood. The first notice of this wood was contained in a letter from East London, Cape Colony, in 1885, addressed to the writer, and in the same year about three tons arrived in London. Samples were submitted to several practical men for trial and report, and they all agreed that the wood did not cut smoothly, but was harsh and ragged, and on the whole that it was far inferior to boxwood. The trees were said to be sufficiently abundant in the East London forests to furnish a large supply of wood. Upon receipt of foliage and flowers at Kew the tree was found to be a new species of *Buxus*, and was named *Buxus Macowani*. The wood has not yet come into general use.

MISCELLANEOUS PRODUCTS.

Under this head are included such products as could not readily be classified under any of the foregoing, but which are, many of them at least, of great commercial and economic interest. A reference to one trade alone will suffice to prove this—we mean the trade in WALKING STICKS and UMBRELLA and PARASOL HANDLES, for while at the present time this is one of the great trades of this country, in the early years of the present century it was practically *nil*. There are no published returns showing the importation of raw material used in this trade, but from figures which we have been at some trouble to obtain, it would seem that of rattan canes alone, imported during the year 1886, there were some 1,500 tons, of the estimated value of £30,000; while other canes imported from the East numbered 28,950,000, valued at £94,000; and to these may be added imports from other parts of the world, as Brazil, Algeria, West Indies, France, etc., bringing up the gross total value of rough material to

£189,000. Placing this against the value of the imports in 1850 of £1,600, it will be seen what progress has been made in this one trade alone, which deals almost exclusively with produce furnished by the vegetable kingdom. Another trade whose operations are confined almost exclusively amongst plants, and which within the last forty years has considerably developed as a branch of English commerce, is that of perfumery, for we not only import attar and essential oils in large and increasing quantities from Roumelia, Singapore, and other places, but the cultivation of perfume plants in this country has received more attention; and when we know that Mitcham lavender and peppermint oils are unequalled in the market, there seems no reason why the cultivation of such plants and the distillation of their oils should not be made specially a home industry. As an illustration of the great value of imported perfumery oils, we will briefly refer to those produced by species of *Andropogon*, which are introductions of the present century; thus LEMON GRASS OIL, the produce of *Andropogon citratus*, was first imported into London about 1832, while RUSA or GINGER GRASS OIL, from *A. Schœnanthus*, was first brought to notice in 1825, and CITRONELLA OIL, from *A. nardus*, at a much more recent period. Citronella and lemon grass plants are extensively cultivated in Singapore and Ceylon for commercial purposes, large plantations in the latter place being devoted to them, and the oil distilled on the spot. Ginger grass oil is chiefly distilled in Khandesh in the Bombay Presidency. Twenty-five years ago, the export of citronella oil from Ceylon was 622,000 ounces, of the value of £8,230, and it has considerably increased since then, besides which are to be added the still greater exports from Singapore, a very large proportion of which comes to this country.

As an illustration of what may be done in the utilisation of waste products, CORK stands forward as a prominent example. Sixty years ago the uses of cork—the bark of *Quercus suber*—were chiefly as stoppers for bottles, floats for nets, in the construction of lifeboats, etc. In 1851, however, the adaptability of cork for very many other domestic and manufacturing purposes was practically illustrated, and its uses became wider and more general. The utilisation of virgin cork for horticultural purposes does not date back more than thirty years; previous to its application for window boxes, rockeries, orchid-growing, etc., it was a waste product, as owing to its irregular growth and porous nature it is quite useless for stoppers. Another use, however, has since been found for it, namely, for grinding into powder, mixing with linseed oil and rubber in the manufacture of the floor covering known as linoleum. In view of the still further extended use of the cork tree, plants have been introduced into India, where they seem to have made healthy and vigorous growth.

VEGETABLE IVORY, the seeds of *Phytelephas macrocarpa*, a low-growing or almost stemless palm, found on the banks of the river Magdalena, and producing large globular bunches of fruits about the size of a man's head, containing numerous seeds which become very hard as they ripen, and being white are extensively used as a substitute for real ivory, chiefly for inlaying, for knobs for drawers, and very largely for coat buttons. Vegetable ivory is said to have been introduced into Europe about the year 1826, but when it first came into commerce in this country is not accurately known.

During the summer of 1878 London, and indeed the whole of the United Kingdom, was deluged with an enormous importation of hats plaited from a kind of sedge. Though they were known to come from China, they soon obtained the name of ZULU HATS, and they found their way even into the remotest villages of the kingdom, being sold at the remarkably low price of one penny each. So abundant were they indeed that the market became glutted, and the hats were sold for use as strawberry guards in gardens by cutting out the crowns. The consul at Ningpo reported that no less than 15,000,000 of these hats, all made by hand, had been exported in one year. The plant from which they are made, which proved to be *Cyperus tegetiformis*, is cultivated especially for this manufacture in rice grounds, and the hats are made by women and children. The same plant is used for making the Chinese matting which has been imported into this country, and so largely used for bed-room and drawing-room floors during the last few years.

The so-called BRIAR-ROOT PIPES, which have now become such a large article of trade, were first introduced to this country about thirty years ago. For some time their origin was quite unknown, and they were made only in small quantities. A flourishing industry is now established at several places in Italy and France, notably at Leghorn, Siena, and Grossitto. The roots of the "briar," which word is a corruption of Bruyère (*Erica arborea*), are collected on the hills of the Maremma, where the plant grows luxuriantly and attains a great size. When brought to the factory the roots are cleaned of the earth which is attached to them, and the decayed parts cut away. They are then cut roughly into pipe shapes and are placed in a vat and gently simmered for twelve hours, by which time they acquire a rich yellowish brown colour, for which the best pipes are noted. The rough

blocks are then put into sacks containing from forty to a hundred each and sent to France, where they are bored and finished off ready for exportation.

Under the name of LOOFAHS our chemists have exhibited in their shops for many years past natural flesh brushes consisting of the vascular tissue of the fruits of *Luffa aegyptiaca*, a climbing cucurbitaceous plant, native of Egypt and Arabia, but grown also in the West Indies and Western Africa, where it is generally known as the TOWEL GOURD. In the countries where the plant grows the vascular network of the fruit is commonly used for straining palm-wine and other fluids, as well as for scrubbing-brushes, and making light ornamental articles, such as baskets, hats, etc. In recent years large factories have been established for the conversion of the Luffa fruits into useful domestic articles, of which soles or socks to place in boots to keep the feet dry and warm in winter and cool in summer are among the most important. They are elastic, and easily washed with soap and water. Saddle undercloths are also made from luffas, and are intended to supplant the felt cloths hitherto used. They fit the saddle perfectly to the back of the horse, and they prevent the animal remaining wet under the saddle after sweating. Surgical bandage stuffs are also made from luffas, and are competing with the wood wool kind introduced some years ago.

The uses to which the Luffa or Loofah may yet be put are very numerous when we consider that they are obtainable in almost any quantity and at a very low rate, some bales received in the London market a few years ago having been sold at five fruits a penny.

A new kind of paint or composition especially intended for coating ships' bottoms to prevent corrosion was brought to notice and experiments made with it in Chatham dockyard in 1873, when a sheet of iron coated with the paint was lowered into one of the basins, and after two years' immersion was found to be practically as clean as when first put down. In 1877 a company was formed under the title of the Protector Fluid Company for manufacturing this paint on a large scale. The fluid, with which any colour can be mixed, was prepared with the juice of one or more species of *Euphorbia* collected, it is said, in Natal. The discovery of this property of the *Euphorbia* juice is said to have been made accidentally when cutting plants of Euphorbia in Natal. It was found that the juice adhered firmly, and coated the blades of the knives, thus preserving them from rust. The value of a preventive against corrosion and the attacks of barnacles is apparent, in saving the cost of frequent cleaning, but nothing has been heard of this paint for some years.

ALGEBRA.—VI.

[Continued from p. 288.]

MULTIPLICATION OF FRACTIONS.

141. By the definition of multiplication, to multiply by a *fraction* is to take a *part* of the *multiplicand* as many times as there are *like parts* of a *unit* in the *multiplier*.

Thus: Suppose a is to be multiplied by $\frac{3}{4}$.

Here, a fourth part of a is $\frac{a}{4}$; and this taken three times is $\frac{a}{4}+\frac{a}{4}+\frac{a}{4}=\frac{3a}{4}$; and so of other cases.

142. To multiply one fraction by another.

Multiply their numerators together, and also their denominators; the products are respectively the numerator and denominator of the answer.

143. *The multiplication may often be shortened by rejecting the same factors from the numerators and denominators of the given fractions.*

EXAMPLE.—Multiply $\frac{a}{r}$, $\frac{h}{a}$, and $\frac{d}{y}$ together.

Here, a being in one of the numerators, and in one of the denominators, may be omitted. The answer is then $\frac{dh}{ry}$. If a be retained, the product will be $\frac{adh}{ary}$; and this reduced to lower terms will become $\frac{dh}{ry}$, the same answer as before.

144. To multiply a fraction and an integer together.

Rule.—Multiply the numerator of the fraction by the integer, and the product with the same denominator is the answer; or divide the denominator by the integer, and the quotient with the same numerator is the answer.

EXAMPLES.—(1) Multiply $\frac{m}{y}$ by a.

Here, $\frac{m}{y}\times a=\frac{am}{y}$. For $a=\frac{a}{1}$; and $\frac{a}{1}\times\frac{m}{y}=\frac{am}{y}$. *Ans.*

(2) Multiply $\frac{m}{ax}$ by a.

Here, dividing the denominator by a, we have $\frac{m}{x}$, which is the answer. Or, by the former part of the rule, multiplying the numerator by a, we have $\frac{am}{ax}$. But $\frac{am}{ax}=\frac{m}{x}$, which is the same result as before.

145. *A fraction is multiplied by a quantity equal to its denominator by cancelling the denominator.*

EXAMPLE.—Multiply $\frac{a}{b}$ by b.

Here, $\frac{a}{b} \times b = a$. For $\frac{a}{b} \times b = \frac{ab}{b}$. But since the quantity b is in both the numerator and denominator, it may be cancelled, and we have a for the product as before.

146. On the same principle, a fraction is multiplied into any *factor* in its *denominator*, by *cancelling that factor.*

EXERCISE 21.

1. Multiply $\frac{3h}{c}$ by $\frac{d}{2m}$.
2. Multiply $\frac{a+d}{y}$ by $\frac{4h}{m-y}$.
3. Multiply $\frac{(a+m) \times h}{3}$ by $\frac{4}{(a-n)}$.
4. Multiply $\frac{a+h}{3+d}$ by $\frac{4-m}{c+y}$.
5. Multiply $\frac{1}{a+3x}$ by $\frac{3}{8}$.
6. Multiply $\frac{a}{b}$, $\frac{c}{d}$, and $\frac{m}{y}$ together.
7. Multiply $\frac{3a}{m}$, $\frac{h-d}{y}$, $\frac{b}{r}$, and $\frac{1}{r-1}$ together.
8. Multiply $\frac{3+h}{11}$, $\frac{1}{h}$, and $\frac{3}{7}$ together.
9. Multiply $\frac{ad}{bc}$, $\frac{a-6}{d+1}$, and $\frac{3}{7}$ together.
10. Multiply $\frac{ad}{m}$, $\frac{3n}{2a}$, and $\frac{ab}{2d}$ together.
11. Multiply $\frac{a+d}{y}$ by $\frac{my}{ah}$.
12. Multiply $\frac{am+d}{h}$, $\frac{h}{m}$, and $\frac{3r}{5a}$ together.
13. Multiply $\frac{3m}{a-y}$ by $(a-y)$.
14. Multiply $\frac{h+3l}{a+m}$ by $(a+m)$.
15. Multiply $\frac{a}{by}$ by y.
16. Multiply $\frac{h}{24}$ by 6.

EXERCISE 22.

1. Multiply $\frac{a}{2}$, $\frac{4r}{5}$, and $\frac{10c}{21}$ together.
2. Multiply $\frac{r}{a}$ by $\frac{a+x}{a-x}$.
3. Multiply $\frac{3r}{2}$ by $\frac{5r}{3y}$.
4. What is the product of $\frac{3r+y}{24a+32c} \times 8$.
5. Multiply $\frac{a+b}{20r+25ry}$ by $5r$.
6. Multiply $\frac{3}{r}$, $\frac{4r}{3}$, and $\frac{a}{b}$ together.
7. Multiply $\frac{abcd}{3x+y}$ by $\frac{3x+y}{abcd}$.
8. Multiply $\frac{a-b}{x}$ by $\frac{x}{a-b}$.
9. What is the product of $\frac{a}{b} \times \frac{c}{d} \times \frac{3}{4} \times \frac{b}{a}$.
10. Multiply $\frac{a+b}{4}$ by $\frac{a-b}{3}$.
11. Find the product of $a \times \frac{bc}{3x} \times 6x$.
12. Find the product $\frac{24ab}{3x} \times \frac{3xy}{8a} \times \frac{3}{4}$.
13. Multiply $\frac{x^2-4a^2}{x-a}$ by $\frac{x^2-a^2}{x+2a}$.
14. Multiply $\frac{a^4}{bx-ab}$ by $\frac{b^2}{x-a}$.
15. Multiply $\frac{1+a+a^2}{1-b+b^2}$ by $\frac{1-a}{1+b}$.
16. Multiply $1-\frac{x-y}{x+y}$ by $2+\frac{2y}{x-y}$.
17. Multiply $\frac{6x^3-4x^2-9x+6}{6x^3+4x^2-9x+6}$ by $\frac{3x^3+2x^2+9x+6}{6x^3-4x^2+3x+2}$

DIVISION OF FRACTIONS.

147. To divide a fraction by a fraction.

Invert the divisor, and then proceed as in multiplication of fractions.

To invert a fraction is to turn it upside down, or to make the numerator the denominator, and the denominator the numerator.

EXAMPLES.—(1) Divide $\frac{a}{b}$ by $\frac{c}{d}$.

Here, we have $\frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$.

To understand the reason of the rule, let it be premised that the product of any fraction by the same fraction inverted is always a unit.

Thus $\frac{a}{b} \times \frac{b}{a} = \frac{ab}{ab} = 1$. And $\frac{d}{h+y} \times \frac{h+y}{d} = 1$.

But a quantity is not altered by multiplying it by a unit. Therefore, if the product of the dividend by the divisor inverted be multiplied by the divisor itself, the last product will be equal to the dividend. Now, by the definition, "division is finding a quotient which, multiplied into the divisor, will produce the dividend." And as the dividend multiplied by the divisor inverted is such a quantity, the quotient is truly found by the rule.

(2) Divide $\frac{m}{2d}$ by $\frac{3h}{y}$.

Here we have $\frac{m}{2d} \times \frac{y}{3h} = \frac{my}{6dh}$. *Ans.*

Proof. $\frac{my}{6dh} \times \frac{3h}{y} = \frac{m}{2d}$ the dividend.

148. To divide a fraction by an integer.

Divide the numerator by the given integer, when it can be done without a remainder; but when this cannot be done, multiply the denominator by the integer.

Thus the quotient of $\frac{am}{b}$ divided by m, is $\frac{a}{b}$.

149. To divide an integer by a fraction.

Reduce the integer to the form of a fraction, and proceed as before. Or, multiply the integer by the denominator, and divide the product by the numerator.

EXAMPLE.—Divide a by $\frac{c}{d}$.

Here, $a = \frac{a}{1}$; and $\frac{a}{1}$ divided by $\frac{c}{d}$ is $\frac{a}{1} \times \frac{d}{c} = \frac{ad}{c}$. *Ans.*

Or, $a \div \frac{c}{d} = \frac{a \times d}{c} = \frac{ad}{c}$. *Ans.* as before.

EXERCISE 23.

1. Divide $\frac{x+d}{r}$ by $\frac{5d}{y}$.
2. Divide $\frac{4dh}{x}$ by $\frac{4hr}{a}$.
3. Divide $\frac{36d}{5}$ by $\frac{18h}{10y}$.
4. Divide $\frac{ab+1}{3y}$ by $\frac{ab-1}{x}$.
5. Divide $\frac{h-my}{4}$ by $\frac{3}{a+1}$
6. Divide $\frac{1}{a-b}$ by h.
7. Divide $\frac{3}{4}$ by 6.
8. Divide xy by $\frac{a+b}{2}$.
9. Divide $ab+cx$ by $\frac{3am}{12d}$.
10. Divide $3ac - x$ by $\frac{a}{3}$.

150. By a former definition "the *reciprocal* of a quantity is the quotient arising from dividing a unit by that quantity."

Thus the reciprocal of $\frac{a}{b}$ is $1 \div \frac{a}{b} = 1 \times \frac{b}{a} = \frac{b}{a}$.

Hence, *the reciprocal of a fraction is the fraction inverted.* For instance: the reciprocal of $\frac{b}{m+y}$ is $\frac{m+y}{b}$; the reciprocal of $\frac{1}{3y}$ is $\frac{3y}{1}$ or $3y$; the reciprocal of $\frac{1}{4}$ is 4. Hence the reciprocal of a fraction whose numerator is 1, is the *denominator* of the fraction. Thus, the reciprocal of $\frac{1}{a}$ is a; of $\frac{1}{a+b}$ is $a+b$ etc.

EXERCISE 24.

1. Divide $\frac{3abc}{x-y}$ by $3ab$.
2. Divide $\frac{10axx+15abx}{10-y}$ by $5ax$.
3. Divide $\frac{3x+11}{x}$ by $3a$.
4. Divide $\frac{a+1-x}{2cd}$ by d.
5. Divide $\frac{a+b}{x}$ by $\frac{a}{b}$.
6. Divide $\frac{x}{3ab}$ by $\frac{y}{4+2m}$
7. Divide $\frac{a+b}{3}$ by $\frac{4}{a+b}$.
8. Divide $\frac{x+y}{a}$ by $\frac{h}{a}$.
9. Divide $\frac{3ab-6xy}{6}$ by $\frac{ab-2xy}{2}$.
10. Divide $21abc$ by $\frac{7ab}{x}$.
11. Divide $8xy$ by $\frac{2ab}{c}$.
12. Divide $18xy$ by $\frac{(2ax-y)}{3m}$.
13. Divide $\frac{18(a+x)}{3}$ by $\frac{2a(a-y)}{2m}$.
14. Divide $2a + \frac{3c+d}{x}$ by $x + \frac{y+h}{2}$.
15. Divide $\frac{ab^2c^3}{xy^2}$ by $\frac{a^3b^2c}{xy^2}$.
16. Divide $\frac{2x-1}{x+2}$ by $\frac{x-3}{3x+1}$.
17. Divide $\frac{y}{y-2}$ by $\frac{y-1}{y^2+2}$.
18. Divide $\frac{a+b}{a+c}$ by $\frac{a-c}{a-b}$.
19. Divide $\frac{x^3-a^2x}{a^2}$ by $\frac{ax-a^2}{x}$.
20. Divide $\frac{xm}{yn}$ by $\frac{xn}{ym}$.
21. Divide $1+\frac{1}{a}$ by $1-\frac{1}{a^2}$.
22. Divide $\frac{x+b}{x}$ by $\frac{x^2-b^2}{xy^2}$.
23. Divide $\frac{ax^2+ab^2}{x^2-ax}$ by $\frac{a^2x+a}{x^3-b^2x}$.
24. Divide $1-\frac{x^2}{x^2+a^2}$ by $1+\frac{a^2}{x^2-a^2}$.
25. Divide $x^2+4a^2+\frac{15a^4}{x^2-4a^2}$ by $x+2a+\frac{8a^2}{x-2a}$.
26. Divide $9x^2-28+\frac{4}{x^2}$ by $3x-4-\frac{2}{x}$.

SIMPLE EQUATIONS.

151. Most of the investigations in algebra are carried on by means of *equations*. In the solution of problems, for example, we represent the *unknown quantity*, or *numbers sought*, by a certain letter; and then, in order to ascertain the *value* of this unknown quantity or letter, we form an *algebraic expression* from the conditions of the question, which is *equal* to some given quantity or number.

EXAMPLE.—A drover bought an equal number of sheep and cows for 840 crowns. He paid 2 crowns a head for the sheep, and 12 crowns a head for the cows. How many did he buy of each.

Here, let $x =$ the number bought of each.

Then $2x =$ the cost of the sheep in crowns.

And $12x =$ the cost of the cows in crowns.

Hence, $2x + 12x = 840$ by the conditions of the question.

Therefore, $14x = 840$ by addition.

And $x = 60$, the number bought of each.

Here, the last expression is obtained from the preceding one by dividing each member by 14, the co-efficient of $14x$.

It will be perceived in this example that the *unknown quantity*, or *number sought*, is represented by the letter x; and from the conditions of the problem we obtain the quantity $14x$, which is equal to the given quantity 840 crowns. This whole *algebraic* expression, $14x = 840$ crowns, is called an *equation*.

152. *An* EQUATION, *therefore, is a proposition expressing in algebraic characters the equality between one quantity or set of quantities and another, or between different expressions for the same quantity.*

This *equality* is denoted by the sign $=$, which is read "is equal to." Thus $x + a = b + e$, and 5 +

$8 = 17 - 4$, are equations, in one of which the sum of x and a is equal to the sum of b and c; and in the other, the sum of 5 and 8 is equal to the difference of 17 and 4.

The quantities on the two sides of the sign $=$ are called *members* of the equation; the several terms on the *left* constituting the *first* member, and those on the *right* the *second* member.

When the unknown quantity is of the *first power*, the proposition is called a *simple equation*, or an equation of the *first degree*.

153. *The reduction of an equation consists in bringing the unknown quantity by itself to one side of the sign of equality, and all the known quantities to the other side, without destroying the equality of the members.*

To effect this, it is evident that one of the members must be as much increased or diminished as the other, or the equality will be destroyed. But the members will remain equal—

(1) If the same or equal quantities be *added* to each. Ax. 1.

(2) If the same or equal quantities be *subtracted* from each. Ax. 2.

(3) If each be *multiplied* by the same or equal quantities. Ax. 3.

(4) If each be *divided* by the same or equal quantities. Ax. 4.

The *principal* reductions in simple equations are those which are effected by *transposition*, *multiplication*, and *division*.

REDUCTION OF EQUATIONS BY TRANSPOSITION.

In the equation $x - 7 = 9$, the number 7 being connected with the unknown quantity x by the sign $-$, the one is *subtracted* from the other. To reduce the equation, let the 7 be *added* to both sides. It then becomes $x - 7 + 7 = 9 + 7$.

The equality of the members here is preserved, because one is increased as much as the other. But on one side we have -7 and $+7$. As these are equal, and have contrary signs, they *balance each other*, and may be cancelled. The equation will then be $x = 9 + 7$.

Here the value of x is found. It is shown to be equal to $9 + 7$, that is, to 16. The equation is therefore reduced. The unknown quantity is on one side by itself, and all the known quantities on the other side.

In the same manner, if $x - b = a$;

Adding b to both sides, we have $\Big\}\ x - b + b = a + b$;

And cancelling as before, we have $\Big\}\ x = a + b$. *Ans.*

154. *When known quantities, therefore, are connected with the unknown quantity by the sign + or —, the equation is reduced by* TRANSPOSING *the known quantities to the other side, and prefixing the contrary sign.*

This is called reducing an equation by *addition* or *subtraction*, because it is, in effect, adding or subtracting certain quantities to or from each of the members.

EXAMPLE. — Reduce the equation $\Big\}\ x + 3b - m = h - d$.

Here, transposing $+ 3b$, we have $\Big\}\ x - m = h - d - 3b$;

And transposing $- m$, $x = h - d - 3b + m$. *Ans.*

155. When several terms on the same side of an equation are *alike*, they must be united in one, by the rules for reduction in addition.

EXAMPLE. — Reduce the equation $\Big\}\ x + 5b - 4h = 7b$.

Here, transposing $5b - 4h$, we have $\Big\}\ x = 7b - 5b + 4h$;

And uniting $7b - 5b$ in one term, we have $\Big\}\ x = 2b + 4h$. *Ans.*

156. The *unknown* quantity must also be transposed, whenever it is on both sides of the equation. It is not material on which side it is finally placed, though it is generally brought to the left-hand side.

EXAMPLE. — Reduce the equation $\Big\}\ 2x + 2h = h + d + 3x$.

Here, by transposition, we have $\Big\}\ 2h - h - d = 3x - 2x$.

And by incorporation [Art. 155] $\Big\}\ h - d = x$. *Ans.*

157. When the *same term*, with the same sign, is on *opposite sides* of the equation, instead of transposing, we may *expunge* it from each. For this is only subtracting the same quantity from equal quantities.

EXAMPLE. — Reduce the equation $\Big\}\ x + 3h + d = b + 3h + 7d$.

Here, by expunging $3h$, we have $\Big\}\ x + d = b + 7d$;

And by transposition and incorporation $\Big\}\ x = b + 6d$. *Ans.*

158. As *all* the terms of an equation may be transposed, or supposed to be transposed, and it is immaterial which member is written first, it is evident that the *signs of all the terms may be changed*, on both sides, without affecting the equality.

Thus, if we have $\qquad x - b = d - a$,

Then by transposition we have $\Big\}\ -d + a = -x + b$;

Or, by changing the places of the members $\Big\}$ $-x+b=-d+a$.

159. If all the terms on *one* side of an equation be transposed, each member will be equal to 0.

Thus, if $x+b=d$, then it is evident that $x+b-d=0$.

Exercise 25.

1. Reduce $a+2x-8=b-4+x+a$.
2. Reduce $y+ab-hm=a+2y-ab+hm$.
3. Reduce $h+30+7x=8-6h+6x-d+b$.
4. Reduce $bh+21-4x+d=12-3x+d-7bh$.
5. Reduce $5x+10+a=25+4x+a$.
6. Reduce $5c+2x+12-3=x+20+5c$.
7. Reduce $a+b-3x=20+a-4x+b$.
8. Reduce $x+3-2x-4=34+3x-4-5x$.
9. Reduce $4x-2+18=5x+8$.
10. Reduce $24-2x=3x-8+2$.
11. Reduce $8+5x-18=6x-22$.
12. Reduce $10x+60+7x=28x+64-12x$.
13. Reduce $y-10-b=6-b$.
14. Reduce $x-10+c-14-c=0$.

REDUCTION OF EQUATIONS BY MULTIPLICATION.

160. When the unknown quantity is connected with a known quantity by the sign of division, the reduction is effected by multiplying both members of the equation by the latter, if it be the divisor; and by the former, if it be the divisor.

In this case, it will be particularly useful to remember a rule formerly given, namely, that a fraction is multiplied by its denominator by removing the denominator; or, in other words, putting down the numerator as the product. Also, that after this process has been performed, transposition is still to be employed as in the preceding examples.

Example.—Reduce the equation $\frac{x}{c}+a=b+d$.

Here, multiplying both sides by c, we have, for the product, $x+ac=bc+cd$; and, by transposition, $x=bc+cd-ac$.

161. Though it is not always *necessary*, yet it is often convenient, to remove the denominators from fractions consisting of *known* quantities only. This is done in the same manner as in the preceding rule.

Example.—Reduce the equation $\frac{x}{a}=\frac{d}{b}+\frac{h}{c}$.

Here, multiplying by a, we have $x=\frac{ad}{b}+\frac{ah}{c}$; again, multiplying by b, we have $bx=ad+\frac{abh}{c}$; lastly, multiplying by c, we have $bcx=acd+abh$. Whence $x=\frac{acd+abh}{bc}$. *Ans.*

162. *An equation may be cleared of fractions by multiplying both members by all the denominators.*

163. In clearing an equation of fractions, it often happens that a numerator becomes a *multiple* of its denominator (*i.e.*, can be divided by it without a remainder), or that some of the fractions can be reduced to *lower* terms. When this occurs, the operation *may be shortened* by performing the division indicated, and by reducing the fractions to their lowest terms.

164. In clearing an equation of fractions, it will be necessary to observe that the sign ·· prefixed to any fraction denotes that the *whole* value is to be subtracted, which is done by changing the signs of *all* the terms in the numerator.

Example.—Reduce $\frac{a-d}{x}=c-\frac{3b-2hm-6n}{r}$

Ans. $x=\frac{(a-d)r}{cr-3b+2hm+6n}$.

Exercise 26.

1. Reduce the equation $\frac{x-4}{6}+5=20$.
2. Reduce the equation $\frac{x}{a+b}+d=h$.
3. Reduce the equation $\frac{6}{10-x}+7=8$.
4. Reduce the equation $\frac{x}{a}=\frac{b}{d}+\frac{c}{g}-\frac{h}{m}$.
5. Reduce the equation $\frac{x}{2}=\frac{2}{3}+\frac{4}{5}+\frac{6}{2}$.
6. Reduce $\frac{x}{3}-\frac{x}{4}=6$.
7. Reduce $\frac{4x}{5}=\frac{3}{5}+\frac{3x}{5}+\frac{8}{10}$.
8. Reduce $2x-\frac{9x}{5}=\frac{10}{25}+\frac{8}{5}$.
9. Reduce $-x+\frac{x}{2}+\frac{3x}{4}-\frac{2x}{7}+\frac{x}{14}=\frac{10}{4}$.

REDUCTION OF EQUATIONS BY DIVISION.

165. *When the unknown quantity contains any known quantity as a factor, the equation is reduced by dividing every term on both members by this known quantity.*

Example.—Reduce the equation $ax+b-3h=d$.

Here, by transposition, we have $ax=d+3h-b$; and dividing by a, we have $x=\frac{d+3h-b}{a}$. *Ans.*

166. If the unknown quantity has co-efficients in *several terms*, the equation must be divided by the sum of all these co-efficients.

Example.—Reduce the equation $3x-bx=a-d$.

Here, $3x-bx=(3-b)x$; and $(3-b)\times x=a-d$.

Whence, dividing by $3-b$, we have $x=$

$$\frac{a-d}{3-b}. \text{ Ans.}$$

167. If any quantity, either known or unknown, is found as a factor in *every term*, both members of the equation may be *divided* by it. On the other hand, if any quantity is a *divisor* in every term, both members of the equation may be *multiplied*

by it. In this way the factor or divisor will be removed, and the reduction may be effected as before.

EXAMPLES.—(1) Reduce the equation $ax + 3ab = 6ad + a$.

Here, dividing by a, we have $x + 3b = 6d + 1$ and, by transposition, $x = 6d + 1 - 3b$. *Ans.*

(2) Reduce the equation $\frac{x+1}{x} - \frac{b}{x} = \frac{h-d}{x}$.

Here, multiplying by x, we have $x + 1 - b = h - d$; and, by transposition, $x = h - d + b - 1$. *Ans.*

168. *A proportion is converted into an equation by making the product of the extremes one member of the equation, and the product of the means the other member.*

EXAMPLE.—Reduce to an equation $ax : b :: ch : d$.

Here the product of the extremes is adx, and the product of the means bch; the equation is, therefore, $adx = bch$. Whence $x = \frac{bch}{ad}$. *Ans.*

169. *An equation may be converted into a proportion by resolving one side of the equation into two factors for the middle terms of the proportion, and the other side into two factors for the extremes.*

EXAMPLE.—Convert the equation $adx = bch$ into a proportion.

Here the first member may be divided into the two factors ax and d; the second into ch and b. From these factors we may form the proportion $ax : b :: ch : d$.

EXERCISE 27.

1. Reduce the equation $2x = \frac{a}{c} - \frac{d}{h} + 4b$.
2. Reduce the equation $ax + x = h + 4$.
3. Reduce the equation $x - \frac{x-b}{h} = \frac{a+d}{4}$.
4. Reduce the equation $x \times (a + b) - a - b = d \times (a + b)$.
5. Reduce to an equation $a + b : c :: h - m : y$.
6. Reduce to a proportion the equation $ay + by = ch - cm$.
7. Reduce the equation $10x + 2 = 34$.
8. Reduce the equation $4x - 8 = -3x + 13$.
9. Reduce the equation $10x - 19 = 7x + 17$.
10. Reduce the equation $8x - 3 + 9 = -7x + 9 + 27$.

KEY TO EXERCISES.

EXERCISE 12.

1. $bceg$.
2. a^3b^3.
3. $60abcdef$.
4. $(a^2 - b^2)^3$.
5. $36a^3$.
6. $a^4 + a^3x - ax^3 - x^4$.
7. $x^4 - a^4$.

EXERCISE 13.

1. $\frac{3m}{4y}$. 2. $\frac{1}{r}$. 3. $\frac{1}{m}$. 4. $\frac{a}{b}$. 5. $\frac{r-1}{h-1}$.

EXERCISE 14.

1. $\frac{2x}{1}$.
2. $\frac{3a + 4a^3}{5}$.
3. $\frac{4a^2 - 6ay + 3y^2}{3a + 2y}$.
4. $\frac{x^2 - ax + a^2}{x + a}$.
5. $\frac{x^2 + ax + a^2}{a}$.
6. $\frac{4a^2 + 6ab + 9b^2}{2a + 3b}$.
7. $\frac{3x^4 - x^3 - x + 3}{x^2 - 6x + 1}$.
8. $\frac{x^3 + x^2 - 2}{2x^2 + 2x + 1}$.
9. $\frac{6x^2 + 8x - 1}{x^2 + 8x - 10}$.
10. $\frac{4x^2 + 9x + 1}{2x^2 - 3x - 2}$.
11. $\frac{4x^3 - x^2 - 3x + 2}{3x^4 - x^2 - 3x + 3}$.

EXERCISE 15.

1. $\frac{dgry}{3gmy}$, $\frac{6hmy}{3gmy}$, $\frac{18cqm}{3gmy}$.
2. $\frac{8dx + 2hx}{3dx + 3hx}$, $\frac{3ad + 3ab}{3dx + 3hx}$, and $\frac{3rx + 3r}{3dx + 3hx}$.
3. $\frac{a-b}{a^2 - b^2}$ and $\frac{a+b}{a^2 - b^2}$.
4. $\frac{amy}{my}$, $\frac{bmy}{my}$, $\frac{hy}{my}$, and $\frac{dm}{my}$.
5. $\frac{adf}{bdf}$, $\frac{bcf}{bdf}$, and $\frac{bde}{bdf}$.
6. $\frac{30hx}{10ab}$, $\frac{2ay}{10ab}$, and $\frac{5ab}{10ab}$.
7. $\frac{2by}{2y}$, $\frac{2x}{2y}$, and $\frac{cy}{2y}$.
8. $\frac{3ryz}{3ayz}$, $\frac{3aby}{3ayz}$, $\frac{9acz}{3ayz}$, and $\frac{ayz}{3ayz}$.
9. $\frac{60cx}{20ac}$, $\frac{5ab}{20ac}$, and $\frac{4acx}{20ac}$.
10. $\frac{28ay}{28by}$, $\frac{140by}{28by}$, $\frac{224br}{28by}$, and $\frac{7by}{28by}$.
11. $\frac{16a^2c}{4acx}$, $\frac{68acx}{4acx}$, $\frac{4axy}{4acx}$, $\frac{4acx^2}{4acx}$, and $\frac{c^2x}{4acx}$.
12. $\frac{a}{a^3b^3}$ and $\frac{b}{a^3b^3}$.
13. $\frac{ax-a}{x^4-1}$ and $\frac{x^3+x^2+x+1}{x^4-1}$.
14. $\frac{x^2-a^2}{x^3+a^3}$ and $\frac{x^2-ax+a^2}{x^3+a^3}$.
15. $\frac{30cdef}{60abcdef}$, $\frac{40adef}{60abcdef}$, $\frac{45abef}{60abcdef}$, $\frac{48abcf}{60abcdef}$, and $\frac{50abcd}{60abcdef}$.

EXERCISE 16.

1. $a + m + \frac{d}{b}$.
2. $m - 1 + dy - \frac{hr}{a}$.
3. $\frac{ah+1}{b}$.
4. $\frac{ac-h}{c}$.
5. $\frac{abx - a + c}{x}$.
6. $\frac{mh + dh - md - d^2 - r}{h - d}$.
7. $\frac{cx - a - b}{c}$.
8. $\frac{adx - ab}{d}$.
9. $\frac{bd - by - c}{d - y}$.
10. $\frac{x^3}{x - a}$.
11. $\frac{2x^2 - a^2}{x + 2a}$.
12. $\frac{12a^2}{4a - 3x}$.
13. $\frac{2a}{a + x}$.

EXERCISE 17.

1. $\frac{2a}{7b+14}$.
2. $\frac{8b + 8h}{30a - 15m}$.
3. $\frac{a^2c^3e^4}{bd^2f^3}$.
4. $\frac{a^2b^2c^2}{d^3}$.
5. $\frac{x^3 + a^3}{x^3 - a^3}$.
6. $\frac{9x^3 - 13x + 4}{x^3 - 19x + 12}$.
7. $\frac{1}{168 - 21a}$.
8. 4.
9. $abcdf$.
10. $4b$.
11. $4y$.
12. $2x$.
13. $\frac{3}{4}axy$.
14. $\frac{1}{2}bx$.
15. $3c + 6x$.
16. $2y - 4a$.
17. $b + x + m + \frac{c + dx}{a}$.
18. (1) $\frac{b}{a}$. (2) $\frac{1}{4y}$. (3) $\frac{x+y}{a+x}$. (4) $\frac{axy - ab}{c + bc}$.
19. $\frac{adx}{dy}$ and $\frac{cy}{dy}$.

20. $\frac{aegy}{bdgy}$, $\frac{bcgy}{bdgy}$, $\frac{bdfy}{bdgy}$, and $\frac{bdgx}{bdgy}$.

21. $\frac{ax-b-c}{x}$.

22. $\frac{4am+4bm-x+y}{4m}$.

23. $\frac{2acx}{3bdy}$.

24. $\frac{abc^2x}{7}$.

EXERCISE 18.

1. $\frac{3hm-2rd-d^2}{3dh}$.
2. $\frac{ay-bd+md}{dy}$.
3. $\frac{am-dy}{my}$.
4. $\frac{a^2+b^2}{a^2-b^2}$.
5. $\frac{ar-am-dh}{dm-dr}$.
6. -6.
7. $\frac{4adx+6bcx+bdm}{bdx}$.
8. $xy+\frac{achx+a^2xy+2cy}{acy}$.
9. $a+c+xy+\frac{ax+bx+4d}{4x}$.
10. $42+2a-\frac{2b}{c}$.
11. $y+\frac{4a+4ab-2x+2y}{2c}$.
12. $2a+2x+1$.
13. $a+\frac{b}{m}$ or $\frac{am+b}{m}$.
14. $3d+\frac{h+d}{m-y}$ or $\frac{3dm-3dy+h+d}{m-y}$.
15. $5x+\frac{a+3b}{c}$ or $\frac{5cx+a+3b}{c}$.

EXERCISE 19.

1. $\frac{ad+dy-hr}{dr}$.
2. $\frac{ay-dm+bm}{my}$.
3. $\frac{adb-d-b}{ab}$.
4. $\frac{17d-9a}{12}$.
5. $\frac{by-dy+bm}{my}$.
6. $\frac{am+m-d^2+d}{dm}$.

EXERCISE 20.

1. $\frac{h}{y}-m$ or $\frac{h-my}{y}$.
2. $a+\frac{bd+ch}{cd}$.
3. $1+\frac{2b-2c}{d}$.
4. $4h-2a-\frac{5d-5b}{6}$.
5. $\frac{ac-cx-bd-by}{bc}$.
6. $\frac{ay+by-cx+dx}{xy}$.
7. $\frac{ad+ay-bc+cx}{bd+by-dx-xy}$.
8. $a-\frac{2x+3dy}{2y}$.
9. $x+y-\frac{a-b}{c}$.
10. $\frac{x^2-y^2-10a+10b}{10x+10y}$.
11. $c-a$.
12. $\frac{y-2x}{xy}$.
13. $\frac{2y-x}{2xy}$.
14. $\frac{a^2z-b^2x}{xyz}$.
15. $\frac{b-3a}{a^3b^3}$.
16. $\frac{1}{x^3+x}$.
17. $4x-\frac{a^2b-a^3}{b^2}$.
18. $\frac{4xy}{x^4-y^3}$.
19. $\frac{2y^3}{x^2+y^2}$.

BOTANY.—XIV.

[*Continued from p. 293.*]

THE CLASSIFICATION OF PLANTS.

WE have now discussed the chief points in the internal and external anatomy in the highest group, or sub-kingdom, of the plant-world. In doing so we have also briefly considered the main functions or physiological characters of their several organs. We saw, however, in our very first lesson, and still more strikingly, perhaps, in the coloured plate in our fifth lesson (Vol. III., p. 153), that the Vegetable Kingdom embraces various other types of plant-life very distinct from, and in some cases almost as numerous as, the flowering plants. Besides the ordinary fruit-bearing or angiospermous plants, including the dicotyledons, represented in that plate by the sunflower, and the monocotyledons, represented by the sugar-cane, there are the gymnosperms, bearing naked seeds, *i.e.*, without closed ovaries or stigmas, represented by the two somewhat distinct types, the yew and the cone-bearing pine. Still more simply organised are the ferns, horsetails, and club-mosses, in which we have no true seeds, but in which there is still a marked distinction between stem and leaf, and a vascular system. Descending the scale of being to the mosses and liverworts, we still find stem and leaf, but the structure is entirely cellular; as it is also in the yet more lowly organised fungi and algæ. In these two great groups true leaves, as lateral appendages of a stem, are no longer recognisable, but we find an immense range in size, and even in organisation, in each series, both in the algæ, or those that contain chlorophyll, and in the fungi, or those that do not. Accordingly in the plate we have the algæ represented not only by the large and familiar bladder-wrack, but also by the microscopic siliceous diatoms; and the fungi represented by the minute yeast-plant and bacteria as well as by the larger agarics, or mushrooms and toadstools, puff-balls, etc. Before describing these lower types, however, we will say a few words upon the general principles of classification adopted in botanical science, and then consider the groups in descending order; beginning, that is, with the most highly organised, as being the larger, more conspicuous, and more familiar forms.

So great is the number of distinct kinds of plants, or *species*, as they are termed in science, that no one could possibly bear them all in mind or recollect their distinctive characteristics. It becomes necessary, therefore, to arrange them in a succession of larger or more general groups according as they agree with one another in many or in fewer characters. We can more readily remember the characters of the comparatively few larger groups, and, knowing them, can on examination refer any plant to its position in the series. We may see a field full of buttercups or daisies, a wood full of primroses or violets, or a moor covered with heather; but when we examine the numerous individuals in either case, we may find that they agree in all essential characters though differing in size, in the number, or even in the shade of colour of their flowers, or in other minor matters. We shall find that the pollen of any one of the buttercups, violets, or heather-bells, will serve to fertilise the

ovules of any other, and that plants springing from seed so fertilised will resemble their parents in all essentials. We express this by saying that all the plants in each case belong to a single *species*, and naturalists of all schools agree that the individuals of a species have all had a common ancestry. In the cases just mentioned, for instance, these may be *Ranunculus acris* (Fig. 65.), *Bellis perennis*, *Primula vulgaris*, *Viola sylvatica*, and *Calluna Erica*; and, as we saw in our first lesson, the second name in each case is the *specific* name, peculiar, that is, to that species. Nevertheless it is by no means easy to determine in every case what characters are sufficiently constant, true to seed, and important, to constitute a species. Among the wood-violets, for instance, we may find that most have broad pointed leaves, broad blue petals with numerous branched dark veins at their base, and a thick yellowish - white spur, but that some have the leaves drawn out into a longer point, the petals narrower and more lilac, with few slightly branched veins, and a compressed dark bluish spur. Some botanists consider these two forms distinct species, naming the second and less common *V. Reichenbachiana*, whilst others call them both *varieties* of *V. sylvatica*, the first "var. *Riviniana*," and the second "var. *Reichenbachiana*," "var." being the abbreviation of "varietas." These two schools are familiarly known as "splitters" and "lumpers." A beginner should accustom himself, by comparing plants with descriptions in thorough works, to note minute differences of structure. Such minute characters as are in most cases relied on in splitting what are termed "critical species" can seldom be readily observed save in living plants.*

Fig. 64.—*Ranunculus repens*, Creeping Buttercup.

In either of the two forms of violet just mentioned, we shall find at the base of the leaf-stalk two small and narrow stipules; but if in a neighbouring corn-field we happen to find the wild pansy, we shall at once see that these are replaced by a pair of large leafy and pinnately lobed stipules. This is only one character that makes us look upon the pansy as a distinct species, *V. tricolor*. Both the wood-violet and the pansy, and in fact all other violets, agree in having monosymmetric flowers with auricles or ear-like lobes at the base of each of their five sepals, a spur to the posterior of the five petals, and tail-like appendages from the base of the connectives of two of the five united anthers. For these reasons we class them together in the *genus Viola*. According to the theory of descent, all the species of a genus are descended from a common ancestry, but from a common ancestry more remote than that common to the individuals constituting a species. So, too, the buttercups of which we have spoken will all agree in having a cylindric peduncle and spreading sepals; but close by, others may be found which send out runners, and have a furrowed peduncle, and others again with a bulb-like base to the stem, a furrowed peduncle, and reflexed sepals. These will belong to the species *R. repens* (Fig. 64) and *R.*

* As a "Flora," or descriptive handbook to British flowering plants, either Professor Babington's "Manual of British Botany" or Sir Joseph Hooker's "Student's Flora" may be recommended.

bulbosus respectively; but in the genus *Ranunculus* there are altogether about two hundred species, about twenty-five of which occur wild in Britain, including such diverse forms as the lesser celandine (*R. Ficaria*) and the water crowfoots. Such a genus as this is often divided for convenience into *sub-genera;* the water crowfoots, for instance, with their white petals with a yellow gland at the base, and some of their leaves generally submerged and much divided, form the sub-genus *Batrachium.* Sub-generic names are not generally mentioned in speaking of a species.

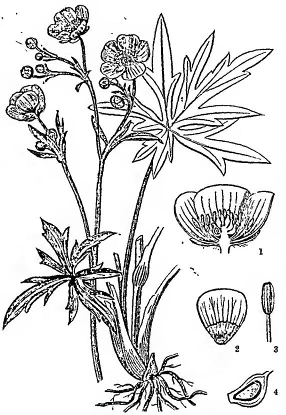


Fig. 65.—*Ranunculus acris,* Common Buttercup. 1 Flower in section. 2. Petal with honey-gland 3. Stamen. 4. Achene in section.

Though mention has only been made of a few characters in each case, it will have been seen that in classing species together in one genus the characters of the whole plant are taken into consideration. We shall find that the genera of flowering plants will commonly have the same number of parts and the same insertion in the flower, the same kind of fruit and seed, and the same general type of leaf in all their species; but that the species will differ from one another in the size and form of the various parts, whilst the mere colour of petals or of fruit is commonly only a varietal character. So far as we endeavour in any stage of our classification to take all the characters of a plant into account, our system is a *natural* one; whilst a system based only upon one set of characters will be an *artificial* one. An artificial system is at best but a mere index, like an alphabetical arrangement, telling us nothing about a plant beyond the one character considered, and both separating, as we should soon find, plants obviously allied to one another, and placing together others that have practically but one character in common. In constructing the Natural system, on the other hand, we may reverently be said to be thinking out for ourselves the thoughts of the Creator, for, according to the theory of descent, which gives us the most rational explanation of the meaning of resemblances, we are reconstructing the pedigree of the Vegetable Kingdom. Taking, therefore, all characters into consideration, and, as Antoine Laurent de Jussieu first pointed out in 1773, weighing their relative importance in the group and not merely counting them, we group genera together into *natural orders,* which may sometimes be subdivided into *tribes.* The Latin names of the orders and families are adjectival, ending in *-æ,* because agreeing with the word *plantæ* understood. Thus, "*Ranunculaceæ*" means "plants allied to *Ranunculus.*" With the genus *Ranunculus,* for instance, we class in one order pæonies, aconites, larkspurs, columbines, hellebores, anemones, clematis, and others. These all agree in certain characteristics, having the calyx polysepalous; petals hypogynous, in form various, sometimes absent; stamens ordinarily numerous; anthers usually adnate; carpels one or numerous, never combined; ovule anatropous; embryo dicotyledonous, small, at the base of a horny albumen; and fruit apocarpous. Of these characters the most essential are the hypogynous stamens and apocarpous fruit. If the student meets with any plant having these characteristics, no matter how different the general appearance of such plant may be from the general appearance of the buttercup, no matter whether the size is different, the shape or colour of the flower different, still it is almost sure to belong to the *Ranunculaceæ.* But what is the use of this classification? the reader may ask. Take a supposed case. You are shipwrecked on some unknown island, or you are a farmer in some unexplored land, and you meet with some gay-looking flowers and tempting-looking herbs; the

fruit is apocarpous and the stamens are hypogynous; then beware of such plants, neither eat them, nor permit your cattle to eat them. They are most likely poisonous, this being a leading physiological characteristic of the tribe; and in certain species the poisonous principle is so extremely virulent that death would speedily result from swallowing a small portion. Such knowledge, not a mere classification of plants without reference to the properties of the members falling under each group, constitutes the really useful part of botany.

Fig. 66.—*Caltha palustris*, the Marsh Marigold. *a*, Essential organs: *st*, stamens; *fr*, ring of follicles; *bl*, receptacle.

Having thus studied the general characteristics of the *Ranunculaceæ*, taking the buttercup as our standard of comparison, let us see how far general appearances may alter without the essential characteristics being interfered with.

What plant is apparently more unlike the buttercup than the clematis? Nevertheless, it will be found on dissection to present the essential characteristics of a ranunculaceous plant.

The larkspurs, again, differ so greatly in appearance from the yellow buttercup, that none but the botanist can see any alliance between them. To his educated eye, however, the affinity is evident. The circumstance in reference to which the name larkspur is given depends upon a curious formation of one of the sepals, something like the spur on a bird's foot; but it is a condition of less botanical importance, thus assisting to indicate a genus, not an order; and colour is of still less botanical importance. Inside the calyx of a larkspur are four petals strangely shaped; two of them having long tails. Thus the larkspur wears a complete mask; but the botanist at once recognises the order by the essential signs of apocarpous fruit and hypogynous stamens; and once recognised, once referred to *Ranunculaceæ*, larkspurs would be justly held in suspicion as poisonous plants, a character which they richly deserve.

When we attempt to group orders into larger divisions, we may well be struck by the distinction, to which reference has been already made more than once, between flowering and flowerless plants.

This distinction was first laid hold of as a basis of classification by the celebrated Linnæus, and to this extent the classification adopted by that great philosopher was strictly natural; beyond this, however, it was altogether artificial, as we shall find hereafter.

Now, taking advantage of this distinction, the great Swedish naturalist termed the evidently flowering vegetables *phænogamous* (from the Greek word φαίνομαι, *phainomai*, I appear); or *phanerogamous*, (from the Greek word φανερός, *phaneros*, evident); and he designated the non-flowering, or, more correctly speaking, the not evidently flowering plants, by the word *cryptogamic* (from the Greek word κρυπτός, *kruptos*, concealed). The department of cryptogamic botany was, however, very imperfectly known to Linnæus; so it was to the classification of flowering plants that his chief efforts were directed, and it is his mode of effecting this that we have to examine. Linnæus arranged all flowering plants under twenty-three classes, founded, as we have seen, on the number and arrangement of the *stamens*. With respect to further divisions of these classes, most of them are divided into orders founded on the number of free carpels or styles entering into the composition of the gynæceum.

The botanist who sets about applying the principles of Linnæus soon finds that the same class is made to contain plants of different natural families, whilst others having affinities to each other are widely separated. It would be unjust to the memory of Linnæus, however, not to say that he recognised the desirableness of classifying vegetables according to their natural alliances, if this could be done; but at the time when he lived a sufficient number of facts to admit of this had not been collected. "All plants," remarks Linnæus, in his botanical philosophy, "are allied by affinities, just as territories come in contact with each other on a geographical chart. Botanists should unceasingly endeavour to arrive at a natural order of classification. Such natural order is the final aim of botanical science. The circumstance rendering such a plan defective now is the insufficient knowledge we have of plants, so many species of which are yet undiscovered. When these species are discovered and described, a natural classification will be accomplished, for nature does not proceed abruptly, as it were by leaps."

These sentiments, made known by the great Swede himself, prove to us that he only intended his artificial classification to be a provisional arrangement. At the same time it may be conceded that it is the best of all the numerous artificial systems which have been propounded. Whilst an artificial system is in its very nature definite, final, and complete, the Natural system must always be susceptible of improvement in detail, representing as it does a summary of all our structural knowledge for the time being.

It is now generally recognised that the Cryptogamia include several distinct types of structure, each of which is of as high a grade of consequence as the Phanerogamia. Among these the lowest is opposed to all higher plants by the absence of a distinct stem and leaves. This type includes the two groups the Algæ and Fungi, which are known collectively as *Thallophyta* (*i.e.*, thallus-plants), their main structure being termed a *thallus*. All

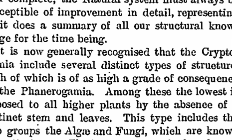


Fig. 67.—Flower of *Anemone* in section: *bl*, ovate receptacle; *k*, petaloid calyx; *st*, stamens; *fr*, carpels.

higher (*i.e.*, non-thallophytic) plants have been termed *Cormophyta*, or stem-plants, as having distinct stems; but here again three types, of which the highest are the Phanerogamia, are now recognised. The two main divisions of cormophytic cryptogams are the *Pteridophyta*, or ferns and their allies, and the *Bryophyta*, or mosses and liverworts.

We may thus divide the vegetable kingdom into four sub-kingdoms; the former groupings of which will be more clearly seen by the following table:—

	Phanerogamia, or Flowering-Plants.	Cormophyta.
Cryptogamia.	*Pteridophyta*, or Ferns and Fern Allies.	Cormophyta.
Cryptogamia.	*Bryophyta*, or Mosses and Liverworts.	Cormophyta.
Cryptogamia.	*Thallophyta*, or Algæ and Fungi.	

These sub-kingdoms are mostly divided into classes, the two highest having, however, a subdivision of a higher grade. A bare enumeration of these classes according to a system which is recommended to us by its simplicity is all that we can attempt as yet for most of the series.

PHANEROGAMIA.
- Division II. *Angiospermia*.
  - Class 12. Dicotyledones.
  - Class 11. Monocotyledones.
- Division I. *Gymnospermia*.
  - Class 10. Gymnospermia.

PTERIDOPHYTA.
- Division II. *Heterosporia*.
  - Class 9. Rhizocarpeæ.
  - Class 8. Ligulatæ.
- Division I. *Isosporia*.
  - Class 7. Lycopodinæ.
  - Class 6. Equisetinæ.
  - Class 5. Filicinæ.

BRYOPHYTA.
- Class 4. Musci.
- Class 3. Hepaticæ.

THALLOPHYTA.
- Class 2. Fungi.
- Class 1. Algæ.

We will for the present confine our attention to the *Angiospermia*, or flowering plants having their ovules in closed ovaries surmounted by stigmas. They are divided into the two classes *Dicotyledones* and *Monocotyledones*, the distinctive characters of which, though already alluded to in various previous lessons, it will be well to summarise here.

Fig. 68.—*Anemone nemorosa*, the Wood Anemone: *gr*, rhizome.

Dicotyledons in the seedling stage, besides having, as their name signifies, two cotyledons, have a radicle, which commonly elongates into a tap-root; whilst Monocotyledons have but one cotyledon and, except among palms, no tap-root, lateral rootlets bursting through the basal portion of the embryo.

The number of fibro-vascular bundles in the root is commonly larger among Monocotyledons than among Dicotyledons.

The stem of Dicotyledons is exogenous, having a limited number of open bundles with a distinctly demarcated central pith, and a well-developed cortical tissue, which can be stripped off with the phloem by tearing through the cambium. That of Monocotyledons has an indefinite number of closed bundles, and neither distinct pith nor separable bark.

Dicotyledons have leaves, often compound, with irregularly reticulate venation, the veins varying

greatly in coarseness, the surface often hairy, the margin often toothed, and stipules often present at the base; whilst those of Monocotyledons are almost always simple, entire, glabrous, exstipulate, and parallel-veined, the veins being seldom of more than two degrees of coarseness, and those sharply contrasted.

Dicotyledons have often two bracteoles on the pedicel, right and left of the flower, and have the floral organs most commonly in fives or twos; Monocotyledons do not have more than one bracteole, which is on the posterior side of the pedicel, and have the parts of the flower in threes.

Lastly, whilst many large groups of Dicotyledons, including the majority of the class, have exalbuminous seeds, the absence of albumen, except among orchids, is quite exceptional among monocotyledons.

Both these great classes are subdivided primarily by characters derived mainly from the perianth, the sub-classes thus formed being again divided into series either by the insertion of the corolla and stamens, or by the character of the bracts. The series are sometimes divided into sub-series, the presence or absence of cohesion in the gynæceum being an important character; and a convenient grouping of the natural orders into larger groups known as cohorts is now commonly employed. It is the grouping employed in the standard work of the late Mr. George Bentham and Sir Joseph Hooker, the "Genera Plantarum." These principal divisions of Angiosperms are shown in the following table:—

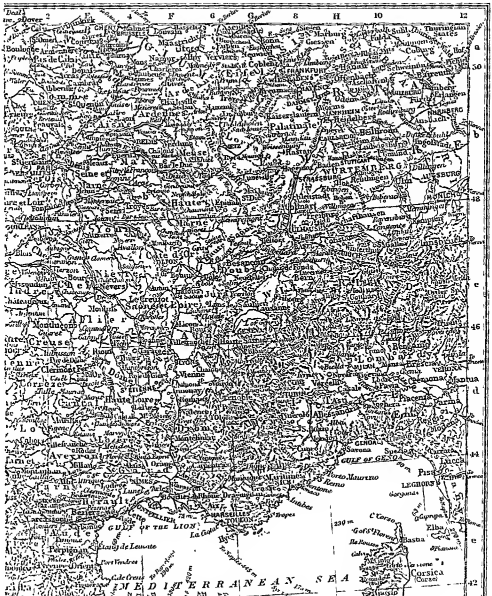
Class DICOTYLEDONES.
- Sub-class III. POLYPETALÆ.
  - Series 3. *Thalamifloræ.*
    - Cohort 6. Ranales.
    - „ 5. Parietales.
    - „ 4. Polygalales.
    - „ 3. Caryophyllales.
    - „ 2. Guttiferales
    - „ 1. Malvales.
  - Series 2. *Discifloræ.*
    - Cohort 4. Geraniales.
    - „ 3. Olacales.
    - „ 2. Celastrales.
    - „ 1. Sapindales.
  - Series 1. *Calycifloræ.*
    - Cohort 5. Rosales.
    - „ 4. Myrtales.
    - „ 3. Passiflorales.
    - „ 2. Ficoidales.
    - „ 1. Umbellales.
- Sub-class II. GAMOPETALÆ.
  - Series 2. *Epigynæ.*
    - Cohort 3. Rubiales.
    - „ 2. Asterales.
    - „ 1. Campanales.
  - Series 1. *Hypogynæ.*
    - Cohort 7. Ericales.
    - „ 6. Primulales.
    - „ 5. Ebenales.
    - „ 4. Gentianales.
    - „ 3. Polemoniales.
    - „ 2. Personales.
    - „ 1. Lamiales.
- Sub-class I. INCOMPLETÆ.
  - Series 2. *Epigynæ.*
    - Cohort 3. Santalales.
    - „ 2. Asarales.
    - „ 1. Quernales.
  - Series 1. *Hypogynæ.*
    - Cohort 7. Nepenthales.
    - „ 6. Chenopodiales.
    - „ 5. Daphnales.
    - „ 4. Euphorbiales.
    - „ 3. Amentales.
    - „ 2. Urticales.
    - „ 1. Piperales.

Class MONOCOTYLEDONES.
- Sub-class II. PETALOIDEÆ.
  - Series 2. *Epigynæ.*
    - Cohort 5. Narcissales.
    - „ 4. Orchidales.
    - „ 3. Amomales.
    - „ 2. Dioscorales.
    - „ 1. Hydrales.
  - Series 1. *Hypogynæ.*
    - Sub-series ii. Syncarpæ.
      - Cohort 2. Liliales.
      - „ 1. Commelynales.
    - Sub-series i. Apocarpæ.
      - Cohort 1. Alismales.
- Sub-class I. NUDIFLORÆ.
  - Series 2. *Glumifloræ.*
    - Cohort 2. Restiales.
    - „ 1. Glumales.
  - Series 1. *Spadicifloræ.*
    - Cohort 3. Palmales.
    - „ 2. Arales.
    - „ 1. Potamales.

When we remember that the 48 cohorts here classified include over 170 natural orders, with an average of about 600 species in 50 genera in each of them, we may form some idea of the variety which flowering plants present to us.

Whilst, however, the 100,000 or more species at present known are being constantly added to, as botanists work out the collections brought home by travellers from the less-known regions of the globe, the number of forms native to any one region is, of course, far more limited. Though a few species occur in almost every part of the earth, others are confined to one continent, or even to a single oceanic island, and some whole orders are exclusively tropical, or belong exclusively either to the Old or to the New World.

FRANCE



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BAY OF BISCAY
Morbihan
Lorient
Belle Isle
Vendée
Navarre
Saragossa
PARIS

Botanists of all nations co-operating in naming, describing, and studying this mass of material, it is inevitable that the same name may be sometimes applied to very distinct forms, one writer, for instance, not understanding the plant intended by a name given by another; or, conversely, the same species may receive two or more names. The rule is that a plant shall bear the name given to it by the botanist who first referred it to its proper genus, beginning with the "Species Plantarum" of Linnæus (1753); and to avoid ambiguity, the name of the botanist describing or placing a plant is added as an "authority" after its name. The generic name is a substantive, and is always written with a capital initial letter; the specific name is an adjective, and is written with a small letter except where it is named after a person or was once the name of a genus. Thus, the Spruce Fir is *Pinus Abies* L. (Linnæus), or *Abies excelsa* DC. (De Candolle), or, more correctly, *Picea excelsa* Link; and the Silver Fir is *Pinus Picea* L., *Pinus Abies* Du Roi, or, more correctly, *Abies pectinata* DC.

Mention may be made here of a few other symbols commonly employed in floras and elsewhere by botanical writers:—

☉ A monocarpic plant.

⊙ An annual plant. ⊚ A biennial plant.

♃ A perennial herb. ♄ A woody plant.

♂ A staminate flower or plant.

♀ A pistillate flower or plant.

☿ A perfect flower, or plant bearing perfect flowers.

? Uncertainty as to the generic or specific name, authority, or locality to which it is affixed.

! Certainty, an authentic specimen—*i.e.*, one so named by the original authority for the name having been seen by the writer, or the plant having been gathered by him in that locality.

v.s.c. (*vidi siccam cultam*). I have seen a dried specimen from a cultivated plant.

v.s.s. (*vidi siccam spontaneam*). I have seen a dried specimen from a wild plant.

v.v.c. (*vidi vivam cultam*). I have seen a living cultivated plant.

v.v.s. (*vidi vivam spontaneam*). I have seen the wild plant in a living state.

FRENCH.—XXIV.

[*Continued from p.* 283.]

TABLE OF THE REGULAR TERMINATIONS OF THE FOUR CONJUGATIONS.

THE following Table will be found useful for reference. It gives in the smallest possible compass the regular terminations of French verbs. We need hardly remind the student that it is placed here for him to consult and not to learn by heart:—

Conjugation.	Infinitive.	Present Participle.	Past Participle.	Person.		Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional. Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
1st ER	CHANT- er.	CHANT- ant.	CHANT- *Sing.* é, *masc.* ée, *fem.* *Plur.* és, *masc.* ées, *fem.*	*Sing.* *Plur.*	1 2 3 1 2 3	CHANT- e, es, e, ons, ez, ent.	CHANT- ais, ais, ait, ions, iez, aient.	CHANT- ai, as, a, âmes, âtes, èrent.	CHANT- er ai, er as, er a, er ons, er ez er ont.	CHANT- er ais, er ais, er ait, er ions, er iez, er aient.	CHANT- e, e, ons, ez, ent.	CHANT- e, es, e, ions, iez, ent.	CHANT- as se as ses, â t, as sions, as siez, as sent.
2nd IR	FIN- ir.	FIN- issant.	FIN- *Sing.* i, *masc.* ie, *fem.* *Plur.* is, *masc.* ies, *fem.*	*Sing.* *Plur.*	1 2 3 1 2 3	FIN- is, is, it, issons, issez, issent.	FIN- issais, issais, issait, issions, issiez, issaient.	FIN- is, is, it, îmes, îtes, irent.	FIN- ir ai, ir as, ir a, ir ons, ir ez, ir ont.	FIN- ir ais, ir ais, ir ait, ir ions, ir iez, ir aient.	FIN- is, isse, issons, issez, issent.	FIN- isse, isses, isse issions issiez, issent.	FIN- is se, is ses, ît, is sions, is siez, is sent.
3rd OIR.	REC- evoir.	REC- evant.	REÇ- *Sing.* u, *masc.* ue, *fem.* *Plur.* us, *masc.* ues, *fem.*	*Sing.* *Plur.*	1 2 3 1 2 3	REÇ-/REC- ois, ois, oit, evons, evez, oivent.	REC- evais, evais, evait, evions, eviez, evaient.	REÇ- us, us, ut. ûmes, ûtes, urent.	REC- evr ai, evr as. evr a, evr ons, evr ez. evr ont.	REC- evr ais, evr ais, evr ait, evr ions, evr iez, evr aient.	REÇ-/REC- ois, oive, evons, evez, oivent.	REÇ-/REC- oive, oives, oive, evions, eviez, oivent.	REÇ- us se, us ses, û t, us sions, us siez, us sent.
4th RE.	VEND- re.	VEND- ant.	VEND- *Sing.* u, *masc.* ue, *fem.* *Plur.* us, *masc.* ues, *fem.*	*Sing.* *Plur.*	1 2 3 1 2 3	VEND- s, s, — ons, ez, ent.	VEND- ais, ais, ait, ions, iez, aient.	VEND- is, is, it. îmes, îtes, irent.	VEND- r ai, r as, r a, r ons, r ez, r ont.	VEND- r ais, r ais, r ait, r ions, r iez, r aient.	VEND- s, e, ons, ez, ent.	VEND- e, es, e, ions, iez, ent.	VEND- is se, is ses, î t, is sions, is siez, is sent.

ALPHABETICAL TABLE

OF THE IRREGULAR, DEFECTIVE, PECULIAR, AND IMPERSONAL VERBS.

The irregular and defective verbs present the greatest difficulty to the student of French. Their irregularities must from the nature of the case be learnt singly and separately. The following table will be found to contain all the verbs in the French language which do not conform to the rules already laid down. We cannot recommend anyone to attempt to learn off so long a list, but it will be well for the student to familiarise himself with them gradually, and always to look up in the table any irregular verb which he meets with in the course of his reading, and not to be content with finding it in its place in the list, but to take the opportunity of noting its various tenses:—

The figures placed after the infinitive of the verbs indicate the conjugations to which they belong.—The tenses not given in this Table are not used.

Infinitive.	Participles.	Indicative.				Conditional Present.	Imperative.	Subjunctive.	
		Present.	Imperfect.	Past Definite.	Future.			Present.	Imperfect.
ABATTRE, 4, *to pull down*	abattant abattu, *f.* -e	j'abats *see* BATTRE	j'abattais	j'abattis	j'abattrai	j'abattrais	abats	j'abatte	j'abattisse
ABSOUDRE, 4, *to absolve* aux. avoir defective	absolvant absous absoute, *f.*	j'absous tu absous il absout n. absolvons v. absolvez ils absolvent	j'absolvais tu absolvais il absolvait n. absolvions v. absolviez ils absolvaient		j'absoudrai tu absoudras il absoudra n. absoudrons v. absoudrez ils absoudront	j'absoudrais tu absoudrais il absoudrait n. absoudrions v. absoudriez i. absoudraient	absous qu'il absolve absolvons absolvez q. i. absolvent	j'absolve tu absolves il absolve n. absolvions v. absolviez ils absolvent	
ABSTENIR (s'), 2, *to abstain*	s'abstenant abstenu, *f.* -e	je m'abstiens ref. *see* TENIR	je m'abstenais	je m'abstins	je m'abstiendrai	je m'abstiendrais	abstiens-toi	je m'abstienne	je m'abstinsse
ABSTRAIRE, 1, *to abstract*	abstrayant abstrait, *f.* -e	j'abstrais *see* TRAIRE	j'abstrayais		j'abstrairai	j'abstrairais	abstrais	j'abstraie	
ACCOURIR, 2, *to run to*	accourant accouru, *f.* -e	j'accours *see* COURIR	j'accourais	j'accourus	j'accourrai	j'accourrais	accours	j'accoure	j'accourusse
ACCROÎTRE, 4, *to increase*	accroissant accru, *f.* -e	j'accrois *see* CROÎTRE	j'accroissais also reflec.	j'accrûs	j'accroîtrai	j'accroîtrais	accrois	j'accroisse	j'accrûsse
ACCUEILLIR, 2, *to welcome*	accueillant accueilli, *f.* -e	j'accueille *see* CUEILLIR	j'accueillais	j'accueillis	j'accueillerai	j'accueillerais	accueille	j'accueille	j'accueillisse
ACHETER, 1, *to buy* — aux. avoir peculiar	achetant acheté, *f.* -e	j'achète tu achètes il achète n. achetons v. achetez ils achètent	j'achetais *like* CHANTER	j'achetai	j'achèterai tu achèteras il achètera n. achèterons v. achèterez ils achèteront	j'achèterais tu achèterais il achèterait n. achèterions v. achèteriez i. achèteraient	achète qu'il achète achetons achetez q. i. achètent	j'achète tu achètes il achète n. achetions v. achetiez ils achètent	j'achetasse *like* CHANTER
ACHEVER, 1, *to complete* aux. avoir peculiar	achevant achevé, *f.* -e	j'achève tu achèves il achève n. achevons v. achevez ils achèvent	j'achevais *like* CHANTER	j'achevai	j'achèverai tu achèveras il achèvera n. achèverons v. achèverez ils achèveront	j'achèverais tu achèverais il achèverait n. achèverions v. achèveriez ils achèveraient	achève qu'il achève achevons achevez q. i. achèvent	j'achève tu achèves il achève n. achevions v. acheviez ils achèvent	j'achevasse *like* CHANTER
ACQUÉRIR, 2, *to acquire* aux. avoir irregular	acquérant acquis, *f.* -e	j'acquiers tu acquiers il acquiert n. acquérons v. acquérez ils acquièrent	j'acquérais tu acquérais il acquérait n. acquérions v. acquériez ils acquéraient	j'acquis tu acquis il acquit n. acquîmes v. acquîtes ils acquirent	j'acquerrai tu acquerras il acquerra n. acquerrons v. acquerrez ils acquerront	j'acquerrais tu acquerrais il acquerrait n. acquerrions v. acquerriez i. acquerraient	acquiers qu'il acquière acquérons acquérez qu'ils acquiè-rent	j'acquière tu acquières il acquière n. acquérions v. acquériez ils acquièrent	j'acquisse tu acquisses il acquît n. acquissions v. acquissiez ils acquissent
ADJOINDRE, 4, *to associate, etc.*	adjoignant adjoint, *f.* -e	j'adjoins *see* JOINDRE	j'adjoignais	j'adjoignis	j'adjoindrai	j'adjoindrais	adjoins	j'adjoigne	j'adjoignisse

ADMETTRE, 4, *to admit*	admettant admis, *f.* -e	j'admets see METTRE	j'admettais	j'admis	j'admettrai	j'admettrais	admets	j'admette	j'admisse
ALLER, 1, *to go* aux. être irregular	allant allé, *f.* -e	je vais tu vas il va n. allons v. allez ils vont	j'allais tu allais il allait n. allions v. alliez ils allaient	j'allai tu allas il alla n. allâmes v. allâtes ils allèrent	j'irai tu iras il ira n. irons v. irez ils iront	j'irais tu irais il irait n. irions v. iriez ils iraient	va qu'il aille allons allez qu'ils aillent	j'aille tu ailles il aille n. allions v. alliez ils aillent	j'allasse tu allasses il allât n. allassions v. allassiez ils allassent
AMENER, 1, *to bring*	amenant amené, *f.* -e	j'amène	j'amenais see ACHEVER	j'amenai	j'amènerai	j'amènerais	amène	j'amène	j'amenasse
AMONCELER, 1, *to heap*	amoncelant amoncelé, *f.* -e	j'amoncelle	j'amoncelais see APPELER	j'amoncelai	j'amoncellerai	j'amoncellerais	amoncelle	j'amoncelle	j'amoncelasse
APPARAÎTRE, 4, *to appear*	apparaissant apparu, *f.* -e	j'apparais see PARAÎTRE	j'apparaissais	j'apparus	j'apparaîtrai	j'apparaîtrais	apparais	j'apparaisse	j'apparusse
APPARTENIR, 2, *to belong*	appartenant appartenu, *f.* -e	j'appartiens see TENIR	j'appartenais	j'appartins	j'appartiendrai	j'appartiendrais	appartiens	j'appartienne	j'appartinsse
APPELER, 1, *to call* aux. avoir peculiar	appelant appelé, *f.* -e	j'appelle tu appelles il appelle n. appelons v. appelez ils appellent	j'appelais *like* CHANTER	j'appelai *like* CHANTER	j'appellerai tu appelleras il appellera n. appellerons v. appellerez ils appelleront	j'appellerais tu appellerais il appellerait n. appellerions v. appelleriez i. appelleraient	appelle qu'il appelle appelons appelez q. i. appellent	j'appelle tu appelles il appelle n. appelions v. appeliez ils appellent	j'appelasse *like* CHANTER
APPRENDRE, 4, *to learn*	apprenant appris, *f.* -e	j'apprends see PRENDRE	j'apprenais	j'appris	j'apprendrai	j'apprendrais	apprends	j'apprenne	j'apprisse
APPUYER, 1, *to support* aux. avoir peculiar	appuyant appuyé, *f.* -e	j'appuie tu appuies il appuie n. appuyons v. appuyez ils appuient	j'appuyais tu appuyais il appuyait n. appuyions v. appuyiez ils appuyaient	j'appuyai *like* CHANTER	j'appuierai tu appuieras il appuiera n. appuierons v. appuierez ils appuieront	j'appuierais tu appuierais il appuierait n. appuierions v. appuieriez i. appuieraient	appuie qu'il appuie appuyons appuyez q. i. appuient	j'appuie tu appuies il appuie n. appuyions v. appuyiez ils appuient	j'appuyasse *like* CHANTER
ASSAILLIR, 2, *to assault*	assaillant assailli, *f.* -e	j'assaille tu assailles il assaille n. assaillons v. assaillez ils assaillent	j'assaillais tu assaillais il assaillait n. assaillions v. assailliez ils assaillaient	j'assaillis tu assaillis il assaillit n. assaillîmes v. assaillîtes ils assaillirent	j'assaillirai tu assailliras il assaillira n. assaillirons v. assaillirez ils assailliront	j'assaillirais tu assaillirais il assaillirait n. assaillirions v. assailliriez i. assailliraient	assaille qu'il assaille assaillons assaillez q. i. assaillent	j'assaille tu assailles il assaille n. assaillions v. assailliez ils assaillent	j'assaillisse tu assaillisses il assaillît n. assaillissions v. assaillissiez i. assaillissent
ASSEOIR (s'), 3, *to sit down* aux. être irregular	s'asseyant assis, *f.* -e	je m'assieds tu t'assieds il s'assied n. n. asseyons v. v. asseyez ils s'asseyent	je m'asseyais tu t'asseyais il s'asseyait n. n. asseyions v. v. asseyiez ils s'asseyaient	je m'assis tu t'assis il s'assit n. n. assîmes v. v. assîtes ils s'assirent	je m'assiérai tu t'assiéras il s'assiéra n. n. assiérons v. v. assiérez ils s'assiéront	je m'assiérais tu t'assiérais il s'assiérait n. n. assiérions v. v. assiériez i. s'assiéraient	assieds-toi qu'il s'asseie asseyons-nous asseyez-vous q. i. s'asseient	je m'asseie tu t'asseies il s'asseie n. n. asseyions v. v. asseyiez ils s'asseient	je m'assisse tu t'assisses il s'assît n. n. assissions v. v. assissiez ils s'assissent
ASTREINDRE, 4, *to compel*	astreignant astreint, *f.* -e	j'astreins see CEINDRE	j'astreignais	j'astreignis	j'astreindrai	j'astreindrais	astreins	j'astreigne	j'astreignisse
ATTEINDRE, 1, *to attain*	atteignant atteint, *f.* -e	j'atteins see CEINDRE	j'atteignais	j'atteignis	j'atteindrai	j'atteindrais	atteins	j'atteigne	j'atteignisse
ATTELER, 1, *to put to, harness*	attelant attelé, *f.* -e	j'attelle	j'attelais see APPELER	j'attelai	j'attellerai	j'attellerais	attelle	j'attelle	j'attelasse
ATTRAIRE, 1, *to attract*	attrayant attrait, *f.* -e	j'attrais see TRAIRE	j'attrayais		j'attrairai	j'attrairais	attrais	j'attraie	
AVENIR, 2, *to happen*	avenant avenu	il avient *it happens*	il avenait *it was happening*	il avint *it happened*	il aviendra *it will happen*	il aviendrait *it would happen*		il avienne *it may happen*	il avînt *it might happen*
AVOIR, *to have*									
AVOIR (y), *there ... to be*	y ayant eu (imp.)	il y a *there is, are*	il y avait *there was, were*	il y eut *there was, were*	il y aura *there will be*	il y aurait *there would be*		il y ait *there may be*	il y eût *there might be*
BATTRE, 4, *to beat* aux. avoir	battant battu, *f.* -e	je bats tu bats il bat n. battons v. battez ils battent	je battais tu battais il battait n. battions v. battiez ils battaient	je battis tu battis il battit n. battîmes v. battîtes ils battirent	je battrai tu battras il battra n. battrons v. battrez ils battront	je battrais tu battrais il battrait n. battrions v. battriez ils battraient	bats qu'il batte battons battez qu'ils battent	je batte tu battes il batte n. battions v. battiez ils battent	je battisse tu battisses il battît n. battissions v. battissiez ils battissent

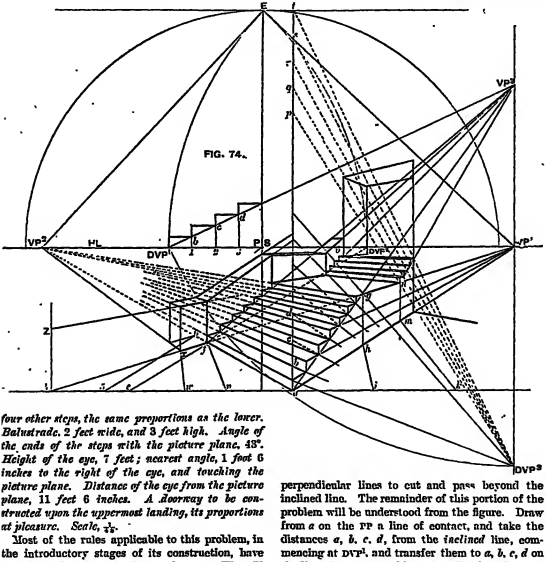
Infinitive.	Participles.	Indicative. Present.	Indicative. Imperfect.	Indicative. Past Definite.	Indicative. Future.	Conditional Present.	Imperative.	Subjunctive. Present.	Subjunctive. Imperfect.
BOIRE, 4, *to drink* aux. avoir irregular	buvant bu, *f.* -e	je bois tu bois il boit n. buvons v. buvez ils boivent	je buvais tu buvais il buvait n. buvions v. buviez ils buvaient	je bus tu bus il bus n. bûmes v. bûtes ils burent	je boirai tu boiras il boira n. boirons v. boirez ils boiront	je boirais tu boirais il boirait n. boirions v. boiriez ils boiraient	bois qu'il boive buvons buvez q.i. boivent	je boive tu boives il boive n. buvions v. buviez ils boivent	je busse tu busses il bût n. bussions v. bussiez ils bussent
BOUILLIR, 2, *to boil.*	bouillant bouilli, *f.* -e	je bous tu bous il bout n. bouillons v. bouillez ils bouillent	je bouillais tu bouillais il bouillait n. bouillions v. bouilliez ils bouillaient	je bouillis tu bouillis il bouillit n. bouillîmes v. bouillîtes ils bouillirent	je bouillirai tu bouilliras il bouillira n. bouillirons v. bouillirez ils bouilliront	je bouillirais tu bouillirais il bouillirait n. bouillirions v. bouilliriez i. bouilliraient	bous qu'il bouille bouillons bouillez q. i. bouillent	je bouille tu bouilles il bouille n. bouillions v. bouilliez ils bouillent	je bouillisse tu bouillisses il bouillît n. bouillissions v. bouillissiez ils bouillissent
BOURRELER, 1, *to torment*	bourrelant bourrelé, *f.* -e	je bourrèle	je bourrelais	je bourrelai	je bourrèlerai	je bourrèlerais	bourrèle	je bourrèle	je bourrelasse
BRAIRE, 4, *to bray*, defect.		il brait ils braient			il braira ils brairont	il brairait ils brairaient			
BRUINER, 4, *to drizzle* impersonal	bruinant bruiné	il bruine *it drizzles*	il bruinait *it was drizzling*	il bruina *it drizzled*	il bruinera *it will drizzle*	il bruinerait *it would drizzle*		qu'il bruine *it may drizzle*	qu'il bruinât *it might drizzle*
BRUIRE, 4, *to roar, rustle* defective		il bruit	il bruissaient ils bruissaient						
CACHETER, 1, *to seal*	cachetant cacheté, *f.* -e	je cachette	je cachetais	je cachetai	je cachetterai	je cachetterais	cachette	je cachette	je cachetasse
CEINDRE, 4, *to gird* aux. avoir irregular	ceignant ceint, *f.* -e	je ceins tu ceins il ceint n. ceignons v. ceignez ils ceignent	je ceignais tu ceignais il ceignait n. ceignions v. ceigniez ils ceignaient	je ceignis tu ceignis il ceignit n. ceignîmes v. ceignîtes ils ceignirent	je ceindrai tu ceindras il ceindra n. ceindrons v. ceindrez ils ceindront	je ceindrais tu ceindrais il ceindrait n. ceindrions v. ceindriez ils ceindraient	ceins qu'il ceigne ceignons ceignez q. i. ceignent	je ceigne tu ceignes il ceigne n. ceignions v. ceigniez ils ceignent	je ceignisse tu ceignisses il ceignît n. ceignissions v. ceignissiez ils ceignissent
CHANCELER, 1, *to stagger*	chancelant chancelé, *f.* -e	je chancelle	je chancelais *see* APPELER	je chancelai	je chancellerai	je chancellerais	chancelle	je chancelle	je chancelasse
CHANGER, 1, *to change* aux. avoir peculiar	changeant changé, *f.* -e	je change tu changes il change n. changeons v. changez ils changent	je changeais tu changeais il changeait n. changions v. changiez ils changeaient	je changeai tu changeas il changea n. changeâmes v. changeâtes ils changèrent	je changerai *like* CHANTER	je changerais	change qu'il change changeons changez q. i. changent	je change tu changes *like* CHANTER	je changeasse tu changeasses il changeât n. changeassions v. changeassiez i. changeassent
CIRCONCIRE, 4, *to circumcise*	circoncisant circoncis	je circoncis tu circoncis il circoncit n. circoncisons v. circoncisez i. circoncisent	je circoncisais tu circoncisais il circoncisait n. circoncisions v. circoncisiez ils circoncisaient	je circoncis tu circoncis il circoncit n. circoncîmes v. circoncîtes ils circoncirent	je circoncirai tu circonciras il circoncira n. circoncirons v. circoncirez ils circonciront	je circoncirais tu circoncirais il circoncirait n. circoncirions v. circonciriez ils circonciraient	circoncis q. i. circoncise circoncisons circoncisez qu'ils-circoncisent	je circoncise tu circoncises il circoncise n. circoncisions v. circoncisiez ils circoncisent	je circoncisse tu circoncisses il circoncît n. circoncissions v. circoncissiez ils circoncissent
CIRCONSCRIRE, 4, *to circumscribe*	circonscrivant circonscrit, *f.* -e	je circonscris *see* ÉCRIRE	je circonscrivais	je circonscrivis	je circonscrirai	je circonscrirais	circonscris	je circonscrive	je circonscrivisse
CIRCONVENIR, 2, *to circumvent*	circonvenant circonvenu, *f.* -e	je circonviens *see* VENIR	je circonvenais	je circonvins	je circonviendrai	je circonviendrais	circonviens	je circonvienne	je circonvinsse
CLORE, 4, *to close* defective	clos, *f.* -e	je clos tu clos il clôt			je clorai tu cloras il clora, etc.	je clorais tu clorais il clorait, etc.	clos qu'il close qu'ils closent	je close tu closes il close n. closions v. closiez ils closent	

GEOMETRICAL PERSPECTIVE.—IX.

[Continued from p. 307.]

PROBLEMS XLIV—XLVIII.

PROBLEM XLIV. (Fig. 74).—*A flight of ascending steps. Angle of ascent, 25°. Seven steps to the first landing, each 8 feet long; tread, or horizontal surface, of each step, 1 foot 2 inches; length of first landing, exclusive of the top step, 8 feet. Afterwards,* ends of the steps is directed to VP¹: the fronts to VP². The angle of inclination of the ascent is constructed from DVP¹, meeting the perpendicular from VP¹ at VP³. (See Problem XXXI., Fig. 53.) Upon this inclined line construct the profiles of a few steps, for a purpose to be explained presently. The simplest way will be to mark the width of each step, 1 foot 2 inches, on the HL, commencing at DVP¹, viz., 1, 2, 3, etc. From these points draw



four other steps, the same proportions as the lower. Balustrade, 2 feet wide, and 3 feet high. Angle of the ends of the steps with the picture plane, 43°. Height of the eye, 7 feet; nearest angle, 1 foot 6 inches to the right of the eye, and touching the picture plane. Distance of the eye from the picture plane, 11 feet 6 inches. A doorway to be constructed upon the uppermost landing, its proportions at pleasure. Scale, $\frac{1}{16}$.

Most of the rules applicable to this problem, in the introductory stages of its construction, have been already given in former lessons. We will merely refer to the details previously explained in their order, and pass on to those which especially belong to the subject. The nearest angle touching the picture plane is at *a*; the ground line of the

perpendicular lines to cut and pass beyond the inclined line. The remainder of this portion of the problem will be understood from the figure. Draw from *a* on the PP a line of contact, and take the distances *a*, *b*, *c*, *d*, from the *inclined* line, commencing at DVP¹, and transfer them to *a*, *b*, *c*, *d* on the line of contact, making seven divisions, because there are to be seven steps. Draw lines from the points thus marked on the line of contact to DVP³, and where they cut the inclined line from *a* to VP³ will be produced the positions of the angles of the

steps. The ends of their horizontal surface or tread must be drawn towards the VP[1]. The fronts of the same must be drawn to VP[2], and the rise will be represented by perpendicular lines meeting the horizontal edges of the steps. For the lengths, the distance of 8 feet must be set off from *a* to *c*. A line drawn from *c* to DVP[2] will determine *a f*, the perspective width. From *f* a line must be drawn to VP[3], and upon it draw the ends of the steps in contact with the face of the balustrade, in the same way as those were on the incline from *a*.

We are now about to use the half-distance point. (*See* lesson VI.) From *g* commences the retiring edge of the landing, *g n*, which is a retiring line of 8 feet; *o* is the half-distance point. Directed by this point, draw a line from *h* to *i*, and make *i k* equal to 4 feet. Rule from *k* back again to *m*; draw the perpendicular *m n*: *g n* will then be the retiring edge of the landing, directed to VP[1]. From *n* draw an inclined line to VP[3]. Through *n*, from DVP[3], draw a line to meet the line of contact in *p*. Make *p*, *q*, *r*, *s*, and *t*, equal to the distances *a*, *b*, *c*, *d*, etc., below. Draw from *q*, *r*, *s*, *t* to DVP[3], cutting the inclined line from *n* to VP[3], for the purpose of constructing the four remaining steps above the landing. These must be done in the same way as those between *a* and *g*. To draw the balustrade, produce a line from *f* to meet the picture plane in the point of contact 4; 4 *z* will be the line of contact. Draw a line through *f* from DVP[1] to *v*; make *v w* equal to 2 feet; rule back again to produce *x*. The width of 2 feet is cut off by drawing a line from *f*, directed by DVP[4], to *c*; make *e* 5 equal to 2 feet; rule from 5 back again to 6. The horizontal parts of the balustrade must be drawn towards VP[1], and the remaining portions up the incline must be directed towards VP[2].

THE PERSPECTIVE OF SHADOWS.

We now enter upon another division of our subject, Sciography, a term which signifies *the science of shadows*. The rules for their projection are founded, generally speaking, upon the same principles as those for the projection of solids and planes; yet, on account of many peculiarities arising from the causes which originate them, in reference to the sources of light, together with the various inclinations of surfaces upon which shadows fall, there must necessarily be additional and distinctive rules for their construction. We might point out a few of these changes in cause and effect, but we think it better to leave them until we come to special cases in which they are found, when we can enter fully into all the particulars belonging to them. The great source of light is the sun, whose rays may be said to be parallel, on account of its great distance from the earth. The rays emanating from an artificial light, as a candle in a room, are not parallel; in this case they spread in all directions from one common centre, upwards, downwards, and horizontally, so that under some conditions we shall have to introduce rules for the construction of shadows subject to an artificial light, which the pupil will find very different from anything that has been previously placed before him. In working the problems relating to shadows, it will be necessary first to draw the perspective representation of the objects we shall have to introduce: an explanation of this part of the work will not be repeated in every case, as we trust our pupils are sufficiently competent to do most of the work that is required previous to determining the shadows. Should there be an exception to this regulation, it will be when a question is proposed in which there may be something unusual in the perspective of the object which has not been considered before.

The position of the sun, the source of light, may be—first, when its rays are parallel with the picture; secondly, when the sun is before or in front of the picture; thirdly, when it is behind the picture.

1st. *When its rays are parallel with the picture.* The sun is either then on the right hand or on the left; its rays, although at an inclination with the ground, are parallel with the picture plane.

2nd. *When the sun is before or in front of the picture;* that is, when it is behind the spectator, or when the spectator is between the sun and the object.

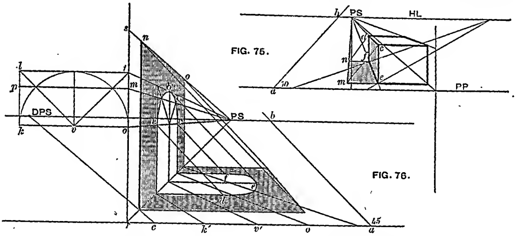
3rd. *When the sun is behind the picture.* By this is meant when the object upon which the light falls is between the sun and the spectator. Our first examples will be to illustrate the first of these positions.

PROBLEM XLV. (Fig. 75).—*A block of stone 3 feet high, 4 feet wide, and 5 feet long, has its ends parallel with the picture plane, 2 feet to the right of the eye and 1 foot within the picture. Height of the eye, 5 feet, and 10 feet from the picture plane. The angle of the inclination of the rays, or the sun's elevation, is 50° with the horizon, and to the right of the eye. Project the shadow of the block.*

Anywhere upon the PP draw an indefinite line *a b*, at an angle of 50° with the PP. Through the angles of the block *c* and *d* draw lines parallel to *a b*, until they meet other lines drawn from *f* and *e* parallel with the PP in *m* and *n*. The side of the block *c d f e* will be the *broad shadow*, that is, the shadow *on the object*; *b f n m* will be the cast shadow on the ground, that is, the shadow *caused by the object*. It will be seen that the edge of the shadow on the ground from the upper edge of the

block retires to the PS, the same vanishing point to which the block retires, because it is parallel with the block.

PROBLEM XLVI. (Fig. 76).—*The face of a wall pierced by an opening having a semicircular arch retires at right angles with the* PP, *nearest end* 1 *foot within the picture. Height of wall,* 9 *feet. Horizontal length,* 10 *feet, and* 5 *feet to the left of*



the eye. Breadth of opening, 5 *feet, and height* 7 *feet. Height of eye,* 5 *feet; distance* 10 *feet. Sun's elevation,* 45°, *and its rays parallel with the picture plane. The thickness of the wall is purposely omitted.*

To draw the perspective elevation of the arch, its elevation must be constructed parallel with the PP. At the given height of the spring of the arch from the ground at *o*, draw *k o* equal to the width of the arch; draw the diagonals *v l* and *v t;* also the horizontal lines *p m* and *l t; p m* must intersect the diagonals where they intersect the arch; these lines meet the line of contact *r s* in *m* and *t*, and are continued on the face of the wall to PS; from *r* to *c* is 2 feet, to cut off from *c* the nearest angle of the wall within the picture; from *c* to *k'* is 2·5 feet, the portion of wall on this side the opening. Lines drawn from *k' v' o'* (equal to *k v o*) to the DPS will cut the base of the wall for the perpendiculars of the opening; between these perpendiculars the parallelogram *l k t o* and the diagonals must be repeated; the corresponding points will be easily recognised, and through them the perspective of the arch must be drawn by hand. For the shadow draw any line *a b*, as in the last problem, at an angle of 45° with the PP, and draw lines parallel to it through *c, b, c*, to meet lines on the ground drawn from the bases of the perpendicular lines *c b* and *c*, and parallel to the PP in the points *d, c, f;* draw the arc *d c f* by hand. The shadows of the angles of the wall *n, o* are found as *d* and *c* in the last problem.

PROBLEM XLVII. (Fig. 77).—*The block of Problem* 45 *has a pole* 10 *feet long laid across it horizontally at an angle of* 40° *with the picture plane. The nearest portion of the pole which is in contact with the block is* 1 *foot from the right-hand corner of the block, and* 2 *feet of the pole as it approaches the picture plano hang over the side. Project the shadows of the block and the pole. Sun's inclination* 50°.

Project the shadow of the block as in Problem XLV. To determine the perspective position of the pole, mark the point *a* 2 feet from *b;* this will include the distance of the block from the PP, and rule it towards DE', cutting *b* PS in *c*. Draw the perpendicular *c d* (*d* marks the edge of the block over which the pole projects). Through *c* and *d* draw indefinite lines towards VP (the vanishing point for the pole); the lower line through *c* will be the plan of the pole. Draw a line from *c* to *c* directed by the DVP, and make *e f* equal to 2 feet; draw a line from *f* towards DVP to meet the plan of the pole in *o;* draw the perpendicular *o m; d m* will then be that part of the pole which projects 2 feet over the side of the block; make *f g* equal to 10 feet, and draw from *g* to DVP, cutting the plan of the pole in *h;* draw the perpendicular *h i;* then the portion of the line between *m* and *i* will be the perspective representation of the pole in the position given. To project the shadow, draw lines from the end of the pole parallel to the sun's inclination, and from *h* draw a line *h k* parallel to the PP to cut the inclined line; from this intersection will be traced the shadow of the pole in the direction of VP, appearing only beyond the shadow of the block.

PROBLEM XLVIII. (Fig. 78).—*Two walls* A *and* B *form a right angle, of these* A *is 40° with the picture* *wall* A, *2 feet from the nearest end; width of doorway, 3 feet; height 7 feet. Horizontal line, 5 feet.*

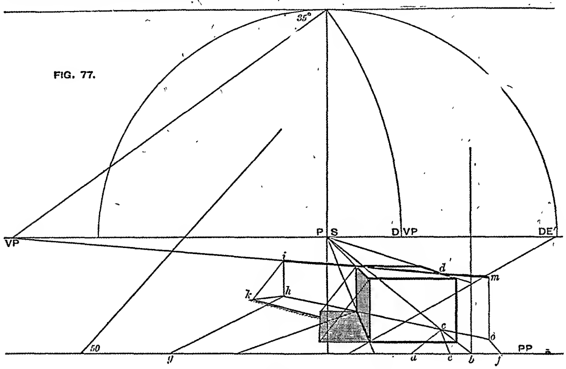


FIG. 77.

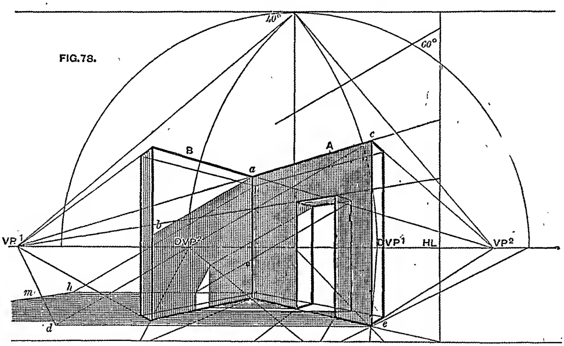


FIG. 78.

plane. Height of the walls, 9 feet 6 inches. Depth of A, *9 feet; that of* B, *7 feet. The nearest angle of the wall* A *is 2 feet from the picture plane, and 5 feet to the right of the eye. A doorway is in the* *Distance of the eye from the picture plane, 10 feet. Angle of sun's rays, 60° with the vertical, and parallel to the plane of the picture.*

In this subject the pupil has to notice especially

the angles of the wall and doorway, from which the lines parallel to the sun's rays are drawn. First, those of the door, where it will be seen the sun's rays are drawn from *the angles on the other side* of the wall, at the top, and the projecting line of the rays for the edge of the shadow on the ground; the opposite edge of the shadow on the ground of the doorway is drawn from the nearest angle of the further perpendicular, because the interior of that side of the doorway is in light. After the lines of the shadow on the ground have met the base of the opposite wall B, they are drawn perpendicularly until they meet their respective inclined lines or sun's rays; the line of the shadow on this wall of the top of the doorway will be easily understood from the figure. The greater portion of the edge of the shadow of the top of the wall A falls on the opposite wall B to *b*, and passes beyond to the ground at *d*, determined by the ray from *c*, and the horizontal line *d c*; the small portion of the shadow on the ground at *d* projected from the upper and near corner of the wall A at *c* retires to VP[1]. The shadow of the angle of the wall B on the ground is found from the outer angle of the two walls on the further side projected at *h*; whilst the edge of the shadow *h m* of the top of the wall retires to VP[2]. We give these general directions as a guide during the process of construction, in preference to giving a close description of the work in detail, that our pupils may have the opportunity of completing the drawing as an exercise.

BOOK-KEEPING.—XVI.

[*Continued from p.* 301.]

SUB-LEDGERS.

A SUB-LEDGER, or Subsidiary Ledger, is conveniently introduced into a set of books, whenever a number of the accounts kept in the business form by themselves a natural and complete group. Thus, whenever a company or private firm has a system of agents or representatives, all of whom render accounts current month by month, or at other stated intervals, the ledger accounts for all these agents or representatives form one group, these accounts being all of them essentially of the same kind. Such a group of accounts, especially when numerous, is oftentimes conveniently detached from the general accounts and kept in a separate volume. When this is done a collective account may be opened in the General Ledger, and into it may be posted, at the time when the books are made up, the totals of the various kinds of debits and credits recorded day by day in the Sub-Ledger. To make this clearer, suppose a Business has agents throughout the country who canvass their district for orders, and, having obtained them, send to head-quarters for the goods; suppose also, for the moment, that the Business sends the goods through the Agent instead of direct to the customer, and that the Agent is responsible for immediately collecting the cash and remitting any money he may not require to his principals; and suppose, to complete the case, that the Agent renders a monthly Account Current, in which he charges himself with the goods received, and credits himself, not only with the expenses allowed for working the agency, but also with commission on the sales he effects, and with his remittances on account; then the book-keeping procedure would be as follows: On the days when any goods were sent to the Agent his account in the Agents' Sub-Ledger would be debited with their value, and credited with the commission thereon; and on the days when any Cash was received from him the same account would be credited. At the end of the month, when his Account Current was received, the expenses charged by him and, after due examination, allowed to him, would be credited in the same Sub-Ledger account.

When all the Accounts Current for the month were received, an abstract of all the expenses charged by the Agents and allowed to them would be made out, and the total expenses for the month thus ascertained. The collective account for Agents in the General Ledger would be constructed at the end of the month, the total value of all the goods sent to the Agents during the month would appear in the summary of the Goods-Sold Book, and would be journalised by debiting the Agents' Collective Account and crediting the accounts for the various goods concerned; the total commission could be got from the same book, and would be journalised by debiting Commission and crediting the Agents' Collective Account. The total expenses is another credit to the Agents' Collective Account, and would be obtained as just explained, and journalised by debiting Trade Expenses and any other account affected (if any). Lastly, the total of the remittances would be shown in the summary of the Cash Book, and would be journalised in journalising the Cash Book, the debit being to Cash and the credit again to the Agents' Collective Account.

The use of a Collective Account has the advantage of rendering the double entry complete within the General Ledger itself, and without reference to the Sub-Ledger. The latter is checked periodically by taking out the gross debit and credit postings respectively, and comparing the total of each with the total of the corresponding side of the Collective Account; or the same thing may be done by working

out the balances instead of the gross postings. The former method of gross postings is the longer process when the work is right, but it has the distinct advantage of showing on which side of the account the error lies, if the work is wrong, and thus of reducing the labour of discovering the error.

In the case of Joint Stock Companies where the number of shareholders is large, the use of a Sub-Ledger for the individual accounts of shareholders is universal.

THE PRIVATE LEDGER.

The Private Ledger is kept exclusively for the information of the proprietor or proprietors of the Business. It is a species of Sub-Ledger, in which the characteristic feature of the accounts appearing in it is the privacy of the information they give. It always contains the Capital Accounts, showing the Partnership Account of each Partner, and also the private Capital Account, if private accounts are in use, besides which it properly contains the account of Profit and Loss, and usually some or all of the Profit and Loss group of accounts. When a Private Ledger is considered necessary, an account entitled "Private Ledger" may be opened in the General Ledger, and into this account may be posted, without exception, and, of course, without a full description in the journal entry, all amounts falling into the Accounts of the Private Ledger. The General Ledger will then present a complete arrangement of double entry, and may be checked without reference to the Private Ledger; while the Private Ledger may be verified by comparison with the account in the General Ledger, like any other Sub-Ledger may be verified.

A counterpart of the "Private Ledger" Account in the General Ledger may be introduced into the Private Ledger. By the counterpart of an account is to be understood a new account formed from the original by writing debit for credit and credit for debit. Every such debit to this fictitious account may be credited to its own proper account, and every credit similarly debited. The Private Ledger would then contain complete double entry, and may be checked and balanced without bringing in the General Ledger Accounts. The entries in the Private Ledger may be journalised in a private journal, and in it their nature may be fully described.

Where a private Ledger is kept, the real Balance Sheet is formed from the Balance Sheet produced from the General Ledger, by omitting the balance on the "Private Ledger" account, and substituting for it its equivalent, viz., the various debit and credit balances of the Private Ledger. This complete Balance Sheet should be recorded in the Private Ledger, or in a separate book kept equally private.

OFFICIAL BOOK-KEEPING.

The Public Accounts record the Imperial Income and Expenditure of the United Kingdom. The greater portion of them, however, are concerned with very limited sections of the whole. The Treasury is responsible for the National Accounts in their entirety. The Customs and the Inland Revenue are Revenue Departments, and are responsible for detailed accounts of the bulk of the National Income, the latter for taxes arising within the kingdom, and the former for duties leviable at the ports; the Post Office is also a revenue department, and responsible for the Income arising from the transmission of letters and of money, and from the carriage of parcels. The Admiralty, the War Office, the Education Department, and others, called the Expending Departments, are responsible for detailed accounts of various expenditure, each of this last group of departments keeping accounts for the particular portion of the National Expenditure which it is authorised to conduct or administer.

The book-keeping involved in the preparation of the national accounts presents less difficulty than that required for the production in due form of the financial record of many commercial and industrial establishments. The National Statement of accounts for the year is in fact a cash account, a cash account of gigantic proportions, and involving many thousand different heads of accounts; but, nevertheless, simply a cash account. Personal accounts, showing cash transactions with individuals, are for the most part restricted to the accounts of sub-accountants—*i.e.*, of consuls abroad and paymasters and other officers at home, who are acting for the chief accountant of the department to which they are responsible; these accounts are generally numerous, but they are all very much alike, and are accordingly dealt with, when the books are made up, by first summarising them. This is done by abstracting the whole of their contents into a summary book ruled in columns; a column for each sub-head of income or expenditure, and adding the columns for the totals which alone are used in the journal entry. In this way we ascertain so much income under one head, so much under another, and so on; and the like for the outgo. All the entries relate to cash transactions. Property on hand does not enter into the ordinary National Statements of accounts, and Property accounts, though sometimes appearing in the shape of Stores accounts, are not to be regarded as an integral part of the National Ledger. Capital accounts, moreover, can have no existence in the national books, for there are no partners who have

found a working capital, or who are entitled to receive a profit on trading or are liable to bear a loss.

The registers of fund-holders kept by the Bank of England are in a certain sense accounts of persons who themselves, or through their predecessors, have furnished advances of money; but these registers are in no sense capital accounts, the proprietors of Government stock having, as such, no voice in the management of the Imperial Finances, and not being affected directly by any considerations of gain or loss. The national accounts, then, though they embrace personal accounts, are mainly of one class only, the class of profit and loss accounts; or, to speak more exactly, the class of Income and Expenditure accounts, income being, from a book-keeping point of view, equivalent to profit, and expenditure to loss. As the national accounts broadly are of one class, instead of four, it follows that the book-keeping required for them is comparatively simple.

The revenue of the country is collected by means of tax collectors, stamp distributors, and customs officers, and money so received is transmitted to the headquarters of the Revenue Departments, and by them paid over to the Exchequer. The accumulation of moneys in one fund, coming as it does from all sources, is known as the *Consolidated Fund.*

Out of this fund, with a few exceptions, the Public Expenditure is met. The expenditure is of two kinds, according to the manner in which it has been authorised by Parliament: firstly, there are the charges of a more distinctly and permanently pledged kind, expressly authorised by special Act of Parliament as immediate and direct charges on the Consolidated Fund, such as the interest on the National Debt, the salaries of the superior judges and of the Auditor-General; and, secondly, there are the charges for which provision is annually voted by the House of Commons, and which are annually authorised, upon the basis of the estimates approved and accepted by the House of Commons, in an Act known as the Appropriation Act, which is an Act directing the appropriation for the specific purposes therein assigned of certain sums of Revenue. In the latter kind of charges, known as the charges for "Voted Services," are included the cost of the naval, military, and civil administration of the country, the grants for education, and many other items of less importance.

The account of income and expenditure published in the newspapers every week shows on the one hand the amount of receipts into the Exchequer, and on the other the amount of advances made to the several departments for their several objects. Such an account, though of great value, is only an approximate statement. The moneys collected by the tax collector do not reach the Exchequer at once, and there is, therefore, always a considerable sum in course of transmission which does not appear in the account; on the other side, the issues from the Exchequer are advances, and have not been wholly exhausted by the spending departments to whom such advances have been made, so that the account is only an approach to what has taken place in respect of the real income and expenditure of the country, but it is sufficiently near to show whether the revenue is expanding or contracting, and whether the expenditure is being kept within due limits.

The procedure in connection with "voted" moneys probably requires a detailed explanation. A sum having been voted by the House of Commons to Her Majesty for a particular service, an intimation of the fact is formally made by the Treasury to the Administrative Department concerned, and upon this the latter debits the Exchequer with the amount so voted, and credits the particular "vote" account. The Paymaster-General, who acts as a kind of supreme cashier for the Government, receives from the Exchequer a grant of so much of the sum voted as he may for the time need, and informs the Administrative Department of the amount, who thereupon debit the Paymaster-General, and credit the Exchequer. The expenditure of the money then goes forward, the authority to pay originating in schedules of orders issued by the Department direct to the Paymaster-General. Upon such an issue the particular sub-heads of the Vote affected are charged, and an account for Orders Payable is at the same time credited. The Paymaster subsequently announces the fact that he has paid certain orders, whereupon the account for Orders Payable is debited, and the Paymaster's account is credited.

Sundry Receipts by an Expending Department are as a rule required to be brought to account, not in diminution of the charges against the Vote, but independently, as Extra Receipts on Votes of Parliament, and an account for "Extra Receipts" is consequently opened and credited. The account to be debited is an account for Orders Receivable, an order directing the Paymaster (or the Bank of England for him), to receive the money being issued by the Administrative Department as soon as it is known that anyone has such moneys to pay over. The Paymaster is not debited until he actually receives the cash, when his account is debited, and Orders Receivable account credited.

The Official Journal is usually made up once a month, and the above-mentioned debits and credits being collected and journalised, the totals are posted into the Ledger.

The charges in course of time having been paid, are recorded in exact accounts, and these accounts are subjected to audit, and laid with the Auditor's report before a Committee of the House of Commons. The Committee on any questionable point summon the Accountant before them, examine him thoroughly, and after hearing his explanations decide whether to recommend the House to allow or disallow the charge in question.

The account having been finally adjusted, any unexpended portion of the full amount voted has to be surrendered to the Exchequer. If by any chance the expenditure in connection with a particular Vote (not sub-head of Vote), has exceeded the amount voted, the Deficiency has to be brought under the consideration of the House of Commons with a view to obtaining from them an additional Vote to cover the Deficiency. Whenever a surrender takes place, the Exchequer is credited and the "Vote" account debited. When a Deficiency is voted and announced, the "Vote" account is credited and the Exchequer debited, just in the same way as the original Vote itself was treated.

HYDRAULICS.—IV.

[Continued from p. 321.]

FLUID PRESSURE ON BODIES IMMERSED—PRINCIPLE OF ARCHIMEDES—REAL AND APPARENT WEIGHT OF BODIES IN WATER AND IN AIR—CORRECTIONS FOR WEIGHTS IN AIR—FLOATING BODIES—CENTRE OF GRAVITY AND CENTRE OF BUOYANCY—CONDITIONS FOR EQUILIBRIUM—METACENTRE.

WHY do bodies weigh less in fresh water than in air, and are still lighter when weighed in brine? In fact, why do some bodies sink in water whilst others rise to the surface of water, and will even float in air? All our experience goes to show that heavy bodies sink and what we call light ones float either in air or water. But what is the exact amount of the force tending to buoy up bodies in fluids such as water or air? For the moment we leave out of account light porous substances, like a sponge, that become soaked with liquid and then sink.

Turning to Fig. 9, p. 319, it is clear that when the body A B C D is at rest in the liquid, and supposing no relative motion between them, the body is kept in equilibrium by its own weight and the resultant upward pressure of the liquid. The downward pressure exerted by the liquid on the end A B is equal to the weight of the column of water A B E F standing on A B as base. The upward pressure exerted by the liquid on the end D C is equal to the weight of the column of water D E F C having D C as base. Obviously the resultant upward pressure is the difference between the weights of these two columns of water; that is, the resultant pressure tends to buoy up the body with a force equal to the weight of a column of water equal to A B C D; hence the *resultant upward force* on the body A B C D *immersed in the liquid is exactly equal to the weight of the water displaced by the body.*

The regular cylindric shape of the body A B C D greatly simplifies the problem, since the horizontal pressures, everywhere normal on its cylindric sides, are exactly equal and opposite all around, and equilibrate one another, having no tendency whatever either to sink or buoy up the body. When the body immersed is irregular in shape, we may establish the same conclusion by the same line of reasoning as that employed in the previous lesson.

While the whole liquid mass remains in equilibrium, and there is no motion of the liquid as a whole, imagine a portion of the liquid corresponding to that occupied by the body immersed to become solidified without any change taking place in its weight or volume. Since this heavy mass of fluid does not fall under the action of gravity, it must be supported by a resultant upward force, due to the upward pressure of the rest of the water, exactly equal in amount to its own weight, and acting vertically upwards in a line through its centre of gravity. Hence the resultant pressure is equal in amount to the weight of the solidified liquid, and acts upwards in a vertical line through its centre of gravity.

Now, any other body immersed in the liquid, and occupying exactly the same place as this solidified portion of the liquid, will be subjected to exactly the same resultant vertical pressure acting vertically upwards in a line which passes through the centre of gravity of the liquid displaced by the body. The water previously occupying the space taken up by the immersed body is called the *displacement*, and the centre of gravity of the water displaced is known as the centre of gravity of the displacement, or simply the *centre of displacement*, and sometimes the *centre of buoyancy*.

The results thus deduced may be expressed in the following proposition, which constitutes the celebrated **Principle of Archimedes**:—

Every body immersed in a liquid or fluid is buoyed up by a force equal to the weight of the fluid displaced, and acting vertically upwards through the centre of buoyancy.

When we bear in mind that a body immersed in a liquid will require a less force to hold it in suspension in the liquid than in vacuo by an amount equal to the resultant upward pressure of the liquid on it, the first part of the Principle of Archimedes may be simply expressed in the following terms:—

Any body immersed in a fluid loses a portion of its weight equal to the weight of the fluid displaced. Experiment proves that this proposition holds true whether the fluid be air, water, or any other liquid which does not act chemically on the body immersed in it.

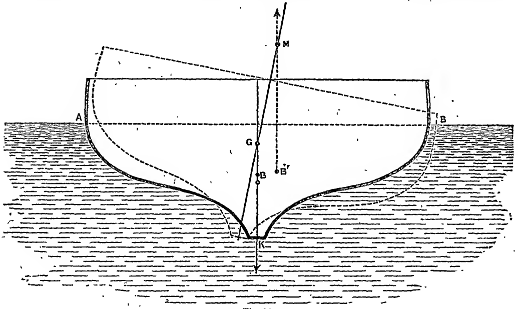


Fig. 11.

Hang from one scale-pan of a sensitive balance a hollow brass cylinder, and attach to the bottom of this hollow cylinder a solid one which can exactly fit into it, so that the solid piece of brass is therefore exactly equal in volume to the capacity of the hollow cylinder. This arrangement hanging in air from the scale-pan is carefully weighed, and accurately balanced by weights placed in the other scale-pan. When equilibrium is obtained, a large deep vessel almost completely filled with water is then brought underneath the cylinders, and gradually raised until the solid cylinder hangs freely in the water and is completely immersed. Equilibrium is thereby destroyed, and the scale-pan containing the weights descends owing to the upward pressure of the water on the solid cylinder attached to the other scale-pan. Now, in order to restore equilibrium, pour water gently into the hollow cylinder while the solid one below it remains completely immersed in the water contained in the vessel placed underneath. It will be found necessary to fill the hollow cylinder with water before balance is again obtained. Thus the weight of the water poured into the hollow cylinder is equal to the loss of weight due to the upward pressure of the water on the solid cylinder which is immersed in the large vessel underneath and displaces exactly the same bulk of water as that poured into the hollow cylinder. We see, then, by this experiment that the solid cylinder, when completely immersed in water, loses weight equal in amount to that of its own bulk of water, which has been poured into the hollow cylinder to restore equilibrium, and which is equal to the weight of the water displaced by the solid body.

Hence, the heavier the liquid the more will the body immersed in it be buoyed up. The loss of weight of any body in a liquid is simply equal to the weight of the volume of liquid displaced by the body. Thus it is that sea water buoys us up more than fresh water, in the proportion of their relative weights—a cubic foot of sea water weighs 64 lb. and fresh water only 62·4 lb. Therefore a smaller volume of sea water than of pure fresh water counterbalances the weight of our body. Consequently we will be inclined to float or swim deeper in pure fresh water than in salt sea water because of the greater buoyancy of the latter. Again, since mercury is about 13·6 times heavier than water, bulk for bulk, it follows that a piece of iron will lose 13·6 times more weight in mercury than it lost when immersed in water, as compared with its usual weight when hanging freely in air.

Another experiment will make this still clearer. A piece of metal or stone, in fact anything heavier than water and which is not acted on chemically

by water, is first suspended by a fine thread from one of the scale-pans of a delicate or sensitive balance and carefully weighed in air. Suppose a cylinder of metal thus carefully weighed in air is found to be balanced by 16 ounces. By means of a fine thread hang the metal from the scale-pan in a vessel filled up to a given mark with water. When the metal is completely immersed, it displaces its own volume of water, which is found to weigh 2 ounces. The metal is buoyed up by the water and weighs only 14 ounces, proving that the loss of weight by the metal in the water is equal to the weight of the water displaced. Thus the water buoys up the metal with a force equal to the weight of the water displaced.

Further, we note in this experiment *a method of determining the volume or bulk of any body of irregular shape.* The difference between the weight of the body in air and in water is really the difference between the weights of air and water of the same bulk as the body. Since the weight of air is insignificant compared with that of water, bulk for bulk, under atmospheric pressure, we may for most practical purposes take the difference between the weights of a body in air and in water as the weight of the water displaced, that is, of a quantity of water of the same bulk as the body. Knowing the weight of this water, we can readily calculate its volume, or bulk, which must necessarily be the same as that of the body which displaces it.

For great accuracy it is necessary to observe several **precautions in weighing** the body. Before placing the weights on the pans, see that the balance swings equally on both sides of the scale. The scale-pans should be carefully cleaned with a flat camel-hair brush. The eye must be kept exactly in front of the scale to avoid parallax in observing the position of the pointer from the centre during a swing. Besides having the balance levelled and in perfect adjustment, care must be taken that there are no air-currents, either due to the heat of the body or to draughts, which would affect the weighing in air.

When weighing the body in water, it is suspended by a single thread of cocoon silk, which is of about the same weight as water, bulk for bulk, so that the portion of it which is in the water will have no weight. The thin elastic surface film of water sticks to the thread, and *damps* or *stills* the vibrations of the balance. On this account it is necessary to use a thin thread. Sometimes great difficulty is experienced in getting rid of air-bubbles absorbed by the water, as well as of the film of air that is likely to be plastered against the body and carried down into the water. To avoid the air-bubbles in the water, the latter should be pure distilled water boiled and allowed to cool to the temperature of the body and balance. The body must be very gradually lowered into the water so as not to carry air down with it; and when it hangs in the water it must be very closely and carefully examined, and any air-bubbles that remain must be removed by a camel-hair brush. Then the weights in the other scale-pan are adjusted until the pointer comes to rest opposite its zero point or position on the scale, showing perfect balance. The temperature of the air and water should be observed at the same time, inasmuch as a considerable variation in the temperature will seriously affect the accuracy of the results by causing expansion of both air and water, so that a given mass of either fluid will occupy larger space, therefore will weigh less bulk for bulk than at a lower temperature, and consequently the buoyancy of both air and water will be less, but not in the same proportion.

CORRECTIONS FOR WEIGHT IN AIR.

Strictly speaking, the body should be, first of all, weighed in vacuo, for when suspended in air it is buoyed up by a force equal to the weight of its volume of air. What we really measure, then, in the above weighing experiment, is the difference between the weights of water and air equal in volume to the body suspended in them. In fact, we conclude that a body suspended in or surrounded by any fluid, such as air or water, is buoyed up by a force equal to the weight of the fluid displaced.

Hence the *apparent* weight of bodies in air is less than their *real* weight in vacuo by the weight of the air displaced. It follows that all the *apparent* weights of bodies in air are, strictly speaking, inaccurate whenever the volumes of the bodies compared on the scale-pans are unequal. The air weighs so little (only ·0807 lb. per cubic foot) that the difference between the real and apparent weights of bodies nearly equal in volume is practically negligible. However, we must bear in mind that whenever the volumes of light bodies weighed in air are widely different, the error becomes appreciable.

If W and W′ be the real weights in vacuo of two bodies of volume V and V′ cubic feet respectively, let the weight of one cubic foot of air be ·0807 lb. Then, if the two bodies are weighed in air and balance each other accurately, we have

$$W - {\cdot}0807\ V = W' - {\cdot}0807\ V',$$

so that

$$W = W' + {\cdot}0807\ (V - V'),$$

which means that the real weight W of the body occupying the large volume V cubic feet, is greater

than the real weight w' of the standard mass with which it is compared when the volume v' of the latter is very small compared with v. We see, in fact, that the difference between the real and apparent weight due to the buoyancy of the air is the amount of error

$$\cdot 0807 (v - v') \text{ lb.},$$

and this vanishes when $v = v'$. Again, we know that the weight of a given volume of air will depend very much upon its pressure and temperature, so that its buoyancy will vary accordingly, and the apparent weight of a body surrounded by air will be different when weighed at different temperatures—

apparent weight = real weight − buoyancy of air.

The resultant force on the body surrounded by air due to the displacement of the air by the body acts vertically upwards through the centre of buoyancy or displacement, and is equal in amount to the weight of the air displaced.

FLOATING BODIES.

CENTRES OF GRAVITY AND BUOYANCY.

We have already seen that a heavy body like solid iron weighs less hanging in water than when it hangs in air from the scale-pan of the balance. However, the weight of solid iron is greater than that of the same bulk of water, so that if left to itself on the surface of this liquid, the iron will sink down through the mass of water. In the same way a copper coin will sink in water, but since it presents a large flat surface the descent will only take place slowly, so that a skilful swimmer can throw a penny into deep clear blue sea-water, and immediately afterwards dive from the boat in time to get below the penny and bring it up long before it reaches the bottom. Bodies *heavier* than water, bulk for bulk, *sink* into it ultimately. When the weight of a solid body is equal to the weight of the water displaced, it will float about wholly immersed in the liquid, and will rest, or may be in equilibrium anywhere in the liquid, because the upward pressure of the water sustains the weight of the body. Moreover, it is further necessary for equilibrium in a liquid such as water, that the *centre of gravity of the body and the centre of buoyancy of the liquid displaced should be in the same vertical line*, so that the upward pressure may not only be equal to the weight of the body which acts downwards, but these forces must act in the same vertical line to balance each other, otherwise the body will tumble about in the liquid. The third condition of stable equilibrium for a body wholly immersed in water is that the *centre of gravity of the body should be below the centre of buoyancy*, so that no amount of tossing will cause the body to become top-heavy or turn upside down.

Again, if the weight of the body is less than the weight of the same bulk of water, the upward pressure of the latter on the body immersed in it will raise the body to the surface, and so cause it to float.

CONDITIONS FOR EQUILIBRIUM.

Floating bodies sink till they occupy under the water-level a space that would contain water just equal to their own weight, because the surrounding water exerts the same resultant pressure whether it be against solid bodies, as ships floating on it, or against the water occupying the same space.

Suppose a solid body which floats in water is lowered into a vessel completely filled up with water. The body will sink into the water to a certain depth and displace some water. If this water be collected and weighed, it will be found that the water displaced by the partial immersion of the body is exactly equal to the weight of the body when these are weighed separately in air.

It is also necessary, when the body is at rest, that the weight of the floating body, which acts downwards through the centre of gravity of the body, should be exactly opposed by the upward resultant pressure of the water acting in the same vertical line; because if these two equal and opposite forces did not act in the same line they would tend to make the body turn. Hence, in order that the floating body may remain at rest its centre of gravity should be in the same vertical line as the centre of gravity of the displacement, that is, the centre of buoyancy, since the water occupying the space of the ship or other floating body is called the "displacement."

Moreover, when the water is not at rest another condition is necessary for the stability of the ship; namely, the centre of gravity of the ship should be below the centre of buoyancy. Thus ballast near the bottom of the ship increases its weight under the water-line, and so lowers the centre of gravity, tending to greater stability; whereas, on the other hand, a heavy cargo on deck raises the centre of gravity, makes the ship top-heavy and liable to overturn when subjected to the smallest heeling motion from the action of the waves.

We may, therefore, enumerate the **conditions of equilibrium and stability** for a body *floating* in a liquid:—

1. The weight of the body must be equal to the weight of the liquid displaced, since a *floating body displaces its own weight of water*.

2. The centre of gravity of the body and the centre of gravity of the liquid, called the centre of buoyancy, must be in the same vertical line.

3. When the floating body heels or is displaced from its position of equilibrium, the centre of

buoyancy must shift towards the lower side, so that the vertical through the new centre of buoyancy intersects the line through the centre of gravity in a point *above* the centre of gravity.

This last condition will be best understood by reference to Fig. 11, in which the heavy full lines represent the section of a boat or ship floating in equilibrium. In this position we observe that G, the centre of gravity of the ship, and B, the centre of buoyancy or centre of gravity of the water occupying the space A B K, are in the same vertical line.

Now if the ship undergoes a slight displacement, or is turned and made to lean slightly on one side from her position of equilibrium, as shown by dotted lines in Fig. 11, in order that the equilibrium may be *stable*, or that the ship may right herself, it is necessary that the centre of buoyancy must shift a distance *d* from the vertical line of the centre of gravity towards the lowered side of the ship to B′, Fig. 11. Then the tendency for the ship to turn or be restored to her former position, called the *righting couple*, bringing her back again to the position of equilibrium, is equal to the weight of the ship multiplied by the leverage *d*—that is, by the horizontal distance B B′ between the centre of gravity of the ship and the new centre of buoyancy B′ for the given displacement.

METACENTRE.

The point M, in which, for a *slight* displacement, the vertical through the new centre of buoyancy B′ intersects the old vertical through the centre of gravity, is called the *metacentre*.

When the *metacentre*, M, is *above* the centre of gravity, G, the action of the forces due to the weight of the ship acting downwards through G, together with the equal and opposite resultant pressure of the water acting upwards through B′, tends to turn the ship back again to the original position of equilibrium. The total turning tendency or righting couple is equal to the weight of the ship multiplied by the perpendicular distance between the vertical lines G K and B′M.

The greater this distance B B′ the greater will be the righting tendency, and the further will the metacentre M be above the centre of gravity. Hence it follows that the righting couple is proportional to the height of metacentre M *above* the centre of gravity, and this height is a measure of the *stability of the ship*.

The position of the point M depends on the shape of the ship or other floating body, and on the position of its centre of gravity, which will greatly depend on the distribution of the cargo or load. We now see the great advantage of ballast, which lowers the centre of gravity and tends to give stability to the ship.

Further, the righting couple called out by the displacement becomes greater and greater the more the ship heels over to increase the horizontal distance B B′, so long as M is above G.

On the other hand, if the ship is *so shaped and loaded* that when she undergoes a slight displacement the metacentre M falls *below* the centre of gravity, then the action of the weight of the ship and upward resultant pressure of the water will go to increase the displacement with a greater and greater turning tendency in that direction, and will finally overturn the ship. The reader can easily construct the diagram for this case of *unstable* equilibrium for different amounts of heeling, and by taking other examples, understand condition (3), that the equilibrium of a floating body is *stable* or *unstable* according as the metacentre for a slight displacement of the body from the position of equilibrium falls *above* or *below* the centre of gravity of the body.

GERMAN.—XXIV

[*Continued from p. 317.*]

Bedenken tragen, ETC.

Bedenken tragen (to bear, *or* have, hesitation) may be rendered "to hesitate," "to doubt," as:—Ich trage Bedenken, es zu thun, I hesitate to do it; Er trug Bedenken, es mir anzuvertrauen, he hesitated to entrust it to me.

Ver compounded with verbs commonly expresses the idea of *away*, a *loss*, *wrong*, etc., as:—Treiben, to *drive*; vertreiben, to drive *away*; Spielen, to *play*; verspielen, to *lose* at play; Leiten, to *guide*; verleiten, *mis*guide (to guide *wrong*). As:—Wie schnell verfließt eine frohe, glückliche Stunde, how quickly a happy, joyful hour passes *away*; Ich habe mich verhört, I have heard *wrong* (misunderstood), etc. Certain uses, however, of this and many others of the same class are best illustrated by examples; thus, sehen signifies to *see*, and versehen, to provide; Legen, to lay; and verlegen, to *mis*lay—also, figuratively, to furnish, and hence to publish (a book), that is, to furnish the necessary means for producing the book, etc.

Ver frequently answers to our "on," as:—Was geht hier vor? what is going on here?

EXAMPLES.

Der Gesand'te trug Beden'ken, allen Worten des Minis'ters zu trauen.	The ambassador hesitated to confide in all the words of the minister.
Dieser Buch'händler hat Göthe's sämmt'liche Werke verlegt'.	This bookseller has published the collected works of Goethe.

Ich habe meine Schlüssel verlegt'.	I have mislaid my keys.
Der junge Mann könnte bei dieser Frage in Verle'genheit kommen.	The young man may get into difficulty by this question.
Dieser Herr will Kegel mit ihm spielen; allein' er hat grö'ßere Lust, eine Partie' Billard zu machen.	This gentleman wishes to play nine-pins with him, but he has (a) greater desire to take a game of billiards.
Mein Bruder spielt das Forte-pia'no, bläst (spielt) die Flöte, und versteht die Trommel zu schlagen (rühren).	My brother plays the piano, blows (plays) the flute, and understands beating (striking) the drum.
Spielt Ihr Fräulein Schwester irgend ein Instrument'?	Does your sister play any instrument?
Sie spielte einmal' auf der Guitar're, jetzt aber spielt sie nicht mehr darauf'.	She played upon the guitar once, but now she plays upon it no more.
Dieser Herr bläst das Waldhorn sehr schön.	This gentleman blows the bugle horn very well.
Ich errieth' den Au'genblick, was ihn so außer Fassung gebracht' hatte.	I divined in an instant what had brought him thus out of (his) self-possession.

VOCABULARY.

Äu'ßerung, *f.* utterance, expression.
Anspruch, *m.* requisition, claim, demand.
Billard, *n.* billiards.
Buch'händler, *m.* bookseller, stationer.
Erra'then, to guess, divine.
Fassung, *f.* self-command, countenance.
Geige, *f.* violin.
Geschick'lichkeit, *f.* skilfulness, cleverness.
Harfe, *f.* harp.
Instrument', *n.* instrument.
Klavier, *n.* harpsichord, piano.
Partie', *f.* game.
Schach, *n.* chess.
Schachmatt', checkmated.
Söhnchen, *n.* little son.
Spieler, *m.* player.
Un'bekannt, unknown.
Verlags'buchhandlung, *f.* publishing-firm.
Weßwe'gen, wherefore, for what reason.

EXERCISE 150.

Translate into English:—

1. Er trug Bedenken, dem Fremden die goldene Uhr anzuvertrauen. 2. Der Vater trug Bedenken, Alles zu glauben, was ihm sein Sohn erzählte. 3. Wer zu viel Bedenken trägt, gewinnt wenig. 4. Sie hielten ihn für einen ordentlichen Menschen. 5. Ich hielt ihn für den Bürgermeister dieser Stadt. 6. Wir hielten ihn für etwas ganz anderes. 7. Der junge Buchhändler hat ein neues Werk verlegt. 8. Ist die neue Grammatik des Herrn N. schon verlegt worden? 9. Sie ist so eben in der Verlagsbuchhandlung des Herrn N. erschienen. 10. Ich bin sehr in Verlegenheit, was ich in dieser Sache thun soll. 11. Die Mutter ist in Verlegenheit, weil sie den Namen der Straße vergessen hat. 12. Er ist in Verlegenheit, woher er die ihm fehlenden zwanzig Thaler nehmen soll. 13. Sie ist in Verlegenheit über das plötzliche Erscheinen eines Unbekannten. 14. Wollen wir eine Partie Schach oder Billard spielen? 15. Ich nehme lieber eine Partie Schach an, da bei diesem Spiele mehr der Verstand, als die Geschicklichkeit in Anspruch genommen wird. 16. Spielen Sie Schach gern? 17. O, ja; nur habe ich zu wenig Gelegenheit, es zu spielen, weßwegen ich bei guten Spielern sehr oft schachmatt werde. 18. Spielen Sie ein Instrument? 19. Ja, ich spiele Klavier, und habe seit einigen Tagen angefangen, Geige zu spielen. 20. Spielen Sie Geige lieber, als Klavier?

EXERCISE 151.

Translate into German:—

1. He hesitated to entrust his attorney with the affair. 2. The mother hesitated to believe everything that her daughter told her. 3. I have mislaid your book, and am therefore in much trouble. 4. The child deceived its teacher, and he therefore hesitated to believe him again. 5. He played at billiards, and lost all his money. 6. Will you play a game at chess with me? 7. No, I prefer a game at billiards, for I do not know much about chess. 8. Do you play any instrument? 9. Yes, I play the harpsichord, and I think of learning the violin. 10. Is your sister skilful at the piano? 11. No, but she is excellent at the harp. 12. At that question he lost all self-command, and knew not how to answer. 13. Mr. C. in London will publish the history of the Kings of England shortly.

Recht, Gefallen.

Recht (right) and link (left) are often used with zur, as:—Zur Rechten, zur Linken, for Zu der rechten Hand, to the right hand; Zu der linken Hand, to the left hand.

Gefallen, literally, "to fall *or* happen" (acceptably). that is, "to be pleasing *or* agreeable," as:—Dieses Buch gefällt mir, this book pleases me. Gefallen lassen = "to submit to," "to put up with," as:—Ich kann mir diese Behandlung nicht gefallen lassen, I cannot submit to this treatment (that is, cannot let this treatment please me).

EXAMPLES.

Es ist Schade, daß bei vielen Menschen die guten An'lagen und Talen'te nicht besser aus'gebildet werden.	It is (a) pity that with many men (the) good endowments and talents are not better developed.
Es ist Schade, daß er nicht da war.	It is (a) pity that he was not there.

Daß ist mir ganz recht.	That just suits me (is just as I'd have it). That serves me right.
Dem frommen Tobi'as war Alles recht, was Gott über ihn verhäng'te.	To the devout Tobias all was right that God ordained concerning him.
Ein Verleum'der muß es sich gefal'len lassen, von seinen Ne'benmenschen verach'tet zu werden.	A calumniator must submit to be despised by his fellow-men.
In dem Stübchen dieser armen alten Frau saß zur Rechten die Noth, und zur Linken das Elend.	In the little room of this poor old woman sat distress at the right hand, and wretchedness at the left.
Rechts sieht man die Schafe auf der Wiese weiden, und links die Ziegen an dem Berge klettern.	At the right are seen the sheep pasturing in the meadow, and at the left the goats clambering upon the mountain.
Morgen über acht Tage reisen wir von hier ab.	A week from to-morrow we depart (hence) from here.
Er beglei'tete seinen Gesang' mit der Harfe.	He accompanied his song with the harp.
Die Beglei'tung dieses Stückes ist von dem berühm'ten Karl Mari'a von Weber.	The accompaniment of this piece is by the celebrated Charles Maria von Weber.
Unter solchen Um'ständen wurde das Versprech'en natür'lich gebro'chen.	Under such circumstances the promise was of course broken.

VOCABULARY.

Auf'stellen, to post, draw up.
Belei'digung, *f.* offence, injury.
Beschlie'ßen, to conclude, resolve, determine.
Gehö'rig, suitable, proper.
Geigenspiel, *n.* violin-music.
Guitar're, *f.* guitar.
Lied, *n.* song, air.
Links, *adv.* to the left.
Mozart, Mozart.
Natür'lich, natural, naturally.
Rechts, *adv.* to the right.
Still'schweigen, to be silent, to hold one's peace.
Untersu'chung, *f.* examination.
Unterwer'fen, to subject, submit.
Verwun'derung, *f.* astonishment, surprise.

EXERCISE 152.

Translate into English:—

1. Es ist Schade, daß Sie nicht eine Stunde früher gekommen sind. 2. Macht es, wie ihr wollt, mir ist Alles recht. 3. Mir ist Alles recht, was die Versammlung beschlossen hat. 4. Er mußte sich diese Beleidigung stillschweigen gefallen lassen. 5. Er mußte sich Vieles gefallen lassen, was er sich unter andern Verhältnissen nicht hätte gefallen lassen. 6. Sie mußte es sich gefallen lassen, verleumdet worden zu sein. 7. Zur Rechten hatten wir das Gebirge, und zur Linken den Fluß. 8. Rechts und links waren feindliche Truppen aufgestellt. 9. Ihr dürft weder zur Rechten, noch zur Linken von diesem Wege abweichen. 10. Wer ist Schuld an diesem Unglücke? 11. Unser Nachbar ist Schuld daran. 12. Der Schüler ist Schuld daran, daß er bestraft wird. 13. Wir selbst sind Schuld daran gewesen. 14. Morgen über acht Tage kommt ein Dampfschiff von New-York an. 15. Morgen über vierzehn Tage wird es ein Jahr, daß ich ihn gesehen habe. 16. Gestern vor acht Tagen ist sein Vater gestorben. 17. Das junge Mädchen begleitete ihren Gesang mit der Guitarre. 18. Der Freund begleitete mit dem Fortepiano das Geigenspiel des Italieners. 19. Die Begleitung dieser Lieder ist von Mozart. 20. Vieles würde uns natürlich erscheinen, wenn wir es einer gehörigen Untersuchung unterwerfen wollten.

EXERCISE 153.

Translate into German:—

1. It is a pity that your friend did not arrive half an hour earlier. 2. I must submit to whatever my father resolves on. 3. John's new book pleases me much. 4. One must submit in this life to many things. 5. I would not submit to it, if I were in your place. 6. To the right hand we had the river, and to the left hand the mountainous forest. 7. Right and left we saw nothing but enemies' troops. 8. This day week we go to Berlin. 9. To-morrow fortnight my brother will arrive here. 10. A week ago yesterday a ship sailed for Australia. 11. Three days ago we had unexpectedly great pleasure. 12. It is a pity that the talents of this young artist are not better developed. 13. Your sister accompanied me with the harp, and sang to the piano of my friend. 14. It is quite natural that everybody must die. 15. The accompaniment of this piece is by Handel.

DATIVE OF PRONOUNS, ETC.

The dative of the personal pronoun of the first and second person (seldom translatable into English) is often employed in familiar style, to intimate in a wholly indefinite manner a participation or interest on the part of the speaker or the person addressed; as:—Ich lobe mir den Knaben, I praise (for myself) the boy; Gehe mir nicht auf's Eis, do not go upon the ice; In der blut'gen Schlacht bei Lützen ritt er Euch unter des Feuers Blitzen auf und nieder mit kühlem Blut (Schiller), in the bloody battle of Lützen he rode, amid the lightnings of the firing, up and down in cool blood.

Davonlaufen = "to run off," "to run away," as:—Er ist bei Nacht und Nebel davon gelaufen, he has run away by night and fog.

Durchgehen has sometimes a like signification, as:—Der Diener ist mit dem Gelde durchgegangen, the servant has run away with the money.

EXAMPLES.

Das Tanzen macht mir kein Vergnü'gen.	Dancing affords me no pleasure.
Ich merke es Ihnen an, daß Sie nicht zufrie'den sind.	I perceive that you are not contented.
Das ist eine verdrieß'liche Sache.	That is a vexatious affair (*or* business).
Die Rede hat die Zu'hörer verdros'sen.	The speech (has) displeased the auditors.
Er ist davon' gelau'fen.	He has run away.
Sehen Sie sich nach einer Wohnung um?	Are you looking about for a residence (boarding place)?
Es geziemt' mir nicht, dem Greise zu widersprech'en.	It does not become me to contradict the aged man.
Ich habe ihn nie mit irgend einem Worte belei'digt.	I have never offended him by a single word.
Der Jähzorn machte Alexan'der dem Großen viel Verdruß'.	Sudden passion caused Alexander the Great much sorrow.
Ich lobe mir jenen Eh'renmann.	I praise that man of honour.

VOCABULARY.

An'merken, to perceive.
Bewir'thung, f. entertainment, reception.
Freundlich, friendly.
Gezie'men, to become, beseem.
Neu'gierig, inquisitive, curious.
Rettung, f. deliverance.
Scheu, shy, skittish.
Somit', consequently, therefore.
Störung, f. disturbance.
Um'sehen, to look about.
Verdrie'ßen, to grieve, vex, trouble.

EXERCISE 154.

Translate into English:—

1. Vielen Menschen scheint es ein Vergnügen zu machen, Andere zu beleidigen. 2. Ich merkte es ihm an, daß er sich beleidigt fühlte. 3. Er beleidigte nicht nur mich, sondern auch meinen Oheim. 4. Diese Sache hat mir schon viel Verdruß gemacht. 5. Der ungerathene Sohn macht dem Vater viel Verdruß. 6. Es verdrießt den Lehrer, eigensinnige Schüler zu haben. 7. Diese Rede verdroß manche Anwesenden. 8. Der verdrossene Knabe ließ seine Arbeit liegen. 9. Es verdroß den Freund, daß ich ihm seine Briefe nicht beantwortete. 10. Ich verdanke ihm meine Rettung. 11. Somit verdanke ich ihm nächst Gott Alles. 12. Wenn es nicht bald anders wird, so laufe ich davon. 13. Bei solchen Ereignissen möchte man davon laufen. 14. Dem Knaben ist sein kleiner Hund davongelaufen. 15. Dem Richter geziemt es, nach der Ursache dieser Störung zu fragen. 16. Es gezieme mir, über diese Sache zu schweigen. 17. Der Neugierige pflegt sich nach jeder Kleinigkeit umzusehen. 18. Ich ging in die Stadt, um mich ein wenig darin umzusehen. 19. Mein Freund will sich nach einer andern Wohnung umsehen. 20. Ich lobe mir die alten Zeiten. 21. Ich lobe mir die schönen Zimmer und die freundliche Bewirthung. 22. Die Pferde wurden scheu, und gingen mit uns durch.

EXERCISE 155.

Translate into German:—

1. It does not become a child to contradict its parents. 2. I went to the town for the purpose of looking about. 3. I admire these beautiful apartments and their pleasant situation. 4. The thief ran away with the money before it was possible to overtake him. 5. He ran away for fear they should take him in the act. 6. It is a vexatious affair that he has lost my money. 7. I perceive that this little present pleases you. 8. I perceive that he has not spoken the truth. 9. Are you looking about for your father? 10. No, I am looking for my friends. 11. I praise these intelligent scholars. 12. Do not fall, little child. 13. My brother shoots a bird from a tree at eighty paces.

KEY TO EXERCISES.

Ex. 142.—1. He spends his time in doing nothing. 2. He spent the greater part of his youth at the gymnasiums and universities of his country. 3. He spends most of his time in useless occupations. 4. Many people pass their time in eating, drinking, and sleeping. 5. With every man who has but a spark of feeling, his fatherland and its welfare excel everything. 6. There is nothing like tranquillity of soul, and the consciousness of having done one's duty. 7. He said his greatest joy and his greatest treasure were his children, and with him nothing surpassed them. 8. A sailor said there was nothing like his pipe. 9. To an indifferent man many things are indeed the same; but he who says that everything is the same to him, is a liar. 10. What we have promised we should perform, whether disadvantage or advantage arises from it. 11. In war all things must be alike to a soldier. 12. A true man patiently adapts himself to all circumstances; it is indifferent to him what he does, but not how he does it. 13. Since his children's death everything is alike to him; he is indifferent about those who surround him, and careless about the course of his affairs. 14. Every man has his free will; therefore, it does not concern me how he employs his time. 15. I travelled by way of (*via*) Rotterdam and London to America. 16. The friend just now went across the street. 17. He pitied the poor boy, therefore he received him into his house, and gave him a good education. 18. He who has no pity for dumb animals, and who is unmerciful towards them, has likewise no pity for mankind.

Ex. 143.—1. Viele Leute bringen ihre Zeit in Trägheit zu. 2. Er brachte den größten Theil seines Lebens in fremden Ländern zu. 3. Jeder Mensch, welcher Gefühl für Ehre hat, entzieht sich keinen Pflichten, welche der Menschheit Nutzen bringen. 4. Er sagt, sein größter Schatz sei Gott, und die ganze Welt, mit Ihm verglichen, sei nichts. 5. Dieser Mann

sagte, es sei ihm ganz einerlei, ob seine Unternehmungen erfolgreich wären oder nicht. 6. Wie viele Sorten Wein haben Sie? 7. Ich habe dreierlei, Sie mögen wählen, welche Sie wollen. 8. Ich gehe jeden Tag zweimal über die Londoner Brücke. 9. Viele gehen über Ostende nach Deutschland. 10. Ich werde wahrscheinlich einen Monat in Bonn zubringen. 11. Mein Nachbar hat dreierlei Enten in seinem Teiche; dieselben sind sehr schön. 12. Dreierlei Rosen wachsen in unserm Garten. 13. Wenn ich hungrig bin, so ist es mir einerlei, ob ich Wildpret oder ein Stück Rindsbraten vor mir habe. 14. Er kaufte Band von dreierlei Farben.

Ex. 144.—1. This year the fruits of the garden, as well as of the field, have turned out well. 2. This tree yields abundance of fruit every year. 3. Is all produce fruit? 4. No, not all, but only that which grows on trees. 5. This young man relies too much upon his relations, and too little upon his own abilities. 6. He depends upon our visiting him next week. 7. He trusted that God would help him. 8. He who relies too much upon others, may easily be deceived. 9. I highly esteem my friends. 10. He thinks much of a comfortable life. 11. This man thinks too much of himself and his prudence, therefore he despises the counsel of well-wishing friends. 12. Only upon this condition can I agree to it. 13. I agree to it if it has no evil consequences. 14. He agreed to it without being acquainted with all the difficulties. 15. This child acts just as if it were at home here. 16. The sailor acted as if he were out of his senses. 17. He behaves as though the greatest wrong had befallen him. 18. This man behaves as though he were offended. 19. He acts like a child of five years of age. 20. The neighbour thrust the intruder out of doors.

Ex. 145.—1. Voriges Jahr sind die Früchte nicht gut gerathen. 2. Dieser Baum trägt nur selten Früchte. 3. Dieser junge Herr verläßt sich zu viel auf seine Fähigkeiten. 4. Nein, er verläßt sich nicht zu viel auf seine Fähigkeiten, denn er weiß, daß es nicht gut ist, sich auf diejenigen Anderer zu verlassen. 5. Ich verlasse mich auf Sie, daß Sie mich nächste Woche besuchen werden. 6. Thun Sie gerade, als ob Sie zu Hause wären. 7. Der Verbrecher stellte sich, als ob er wahnsinnig wäre. 8. Dieser Mann stellt sich gerade wie ein Kind. 9. Wo ist Ihr Kanarienvogel? Er ist zum Fenster hinaus geflogen. 10. Wie kann ich in eine Sache einwilligen, die gegen meine Neigung ist? 11. Ein jeder, der sich entzweit, wird aus dem Hause getrieben. 12. Es hängt von Umständen ab, ob ich zu meinen Freunden gehen werde. 13. Jeder Mensch strebt unabhängig zu werden. 14. Verlasse dich darauf, daß ich dir nicht wieder helfen werde.

Ex. 146.—1. It is not your fault that you are so unhappy. 2. It was not his fault that he broke this glass. 3. I can give nothing for it, except my thanks. 4. I shall state the reasons for it, if it be requested. 5. Can you tell me what o'clock it is? 6. No, for my watch has stopped. 7. Has your watch stopped long? 8. Yes, nearly an hour. 9. My watch goes too fast; it has gained nearly half an hour. 10. My friend's watch is five minutes too fast. 11. Good-bye, and do not forget to visit me soon again. 12. Good-bye, sir. 13. When shall we both visit Mr. N.? 14. It depends entirely upon you what time you wish to appoint for it; I am ready at any time to accompany you. 15. It depends upon you to save or to ruin this family. 16. The neighbour works in his garden, and tries to put it in order. 17. With all his exertions he never settles this matter. 18. He tried to get me into the ranks of his comrades. 19. It is difficult to accustom a disorderly man to regularity. 20. After great trouble he has cleared up the account.

Ex. 147.—1. Ich kann nicht dafür, daß Sie das Unglück gehabt haben. 2. Sie konnten nicht dafür, daß die Magd den Teller zerbrochen hat. 3. Er konnte mir nichts dafür geben, als seinen Dank. 4. Er konnte nichts dafür, er sprach nur die Wahrheit. 5. Kann der Kutscher etwas dafür, daß der Wagen umgeworfen wurde? 6. Nein, er konnte nichts dafür, denn die Pferde waren nicht zu beruhigen. 7. Können Sie mir sagen, welche Zeit es ist? 8. Nein, meine Uhr geht nach. 9. Die Stunde meiner Abreise zu bestimmen hängt von meinen Eltern ab. 10. Leben Sie wohl, Madam; und vergessen Sie nicht, mich Ihren Eltern zu empfehlen. 11. Es hängt von Ihnen ab, welche Zeit Sie bestimmen wollen, Ihre Freunde zu besuchen; ich werde stets bereit sein, Sie zu begleiten. 12. Glück und Unglück, Leben und Tod, Armuth und Reichthum, Alles hängt von dem Willen Gottes ab.

Ex. 148.—1. The thief was convicted of his crime, and of course he will be punished. 2. The father went away this morning, and has not yet returned. 3. The book has been lost, and all these scholars pretend not to know where it has gone to. 4. My nephews went away without saying where they were going. 5. Our fruit is all gone. 6. Any amount of money will go if one is wasteful. 7. The Turkish emperor, Soliman II., said, shortly before his death, "My strength is gone, but not my courage." 8. How far are you going to walk? 9. I walk till I get tired, generally as far as the park. 10. My friend knows very well how far he has to go in this affair. 11. Even in joke one ought to know how far one can go, because even in jest one may offend. 12. Where are you going? 13. I am going to my attorney. 14. How far have you to go? 15. To the end of the town. 16. How long will it take you to walk? 17. More than an hour. 18. How far have you walked? 19. I have been as far as the river. 20. How long have you been walking? 21. I have been walking above half an hour. 22. How long have you been from home? 23. I have been away three-quarters of an hour. 24. Have you been far away from it? 25. I have been nearly half an hour's walk from home. 26. I hope to see you again, whether it be in this world or in the next.

Ex. 149.—1. Sagen Sie mir, ob das Ihr eigenes Pferd ist? 2. Jener Pächter sagte mir manches über Landwirthschaft. 3. Ich werde heute nicht ausgehen, es sei denn, daß die Nothwendigkeit mich zwingt. 4. Ihr werdet nicht in das Himmelreich kommen, es sei denn, daß Ihr die Wohlthaten des Herrn anerkennt. 5. Mein Bruder ging gestern fort, und wir haben nichts von ihm gehört. 6. Es versteht sich von selbst, daß die Menschen, Thiere und Pflanzen nicht ohne Nahrung leben können. 7. Mein Messer ist fort, und keines von den Kindern weiß, wo es ist. 8. Unser Geld ist alle. 9. Ich weiß recht gut, wie weit ich in dieser Sache zu gehen habe. 10. Wohin gehen Sie? 11. Ich gehe zu meinem Bruder. 12. Wie weit haben Sie zu gehen? 13. Bis an den Park. 14. Wie weit haben Sie zu gehen? 15. Ungefähr drei Viertel Meilen. 16. Er glaubte, die Zeit sei nun gekommen, sich seinen eigner Weg durch's Leben zu bahnen.

PNEUMATICS.—III.

[Continued from p. 311.]

LAWS OF EXPANSION AND COMPRESSION OF GASES —DETERMINATION OF THE CO-EFFICIENT OF EXPANSION—SIMPLE GENERAL LAW FOR GASES —NUMERICAL EXAMPLES.

It is evident from our consideration of Boyle's law for gases that, for a given mass or quantity of gas, the product of its pressure and volume depends on the constant temperature at which the gas is kept; and that for every temperature this product will be equal to some constant number. Now what is the relation between this number and the temperature for a given mass of gas?

The answer to this question may perhaps be more clearly understood by first of all considering separately the changes produced in either of the two factors—pressure and volume of a gas—by variation of temperature.

About 1787 the rough experiments of **Charles** led him to the conclusion that if the pressure be kept constant, all gases expand equally and uniformly for equal increments of temperature, as indicated by the ordinary mercurial thermometer. That is to say, *when the pressure remains constant, the volume of a gas is directly proportional to the temperature.*

The subsequent measurements of Gay Lussac determined the numerical relation between volume and temperature, and not only told us the value of the co-efficient of increase in volume for any one gas, but pointed out the general law that this co-efficient is practically the same for all ordinary gases within the range of temperature between 0° Cent. and 100° Cent.

The still more exact results obtained by Regnault in his elaborate and classic investigations tend to fully establish the

LAW OF CHARLES.

Gases expand $\frac{1}{273}$rd of their volume at 0° Cent. for an increase in temperature of 1° Cent., when heated under constant pressure.

The range of temperature and pressure for which this law is strictly true is limited for every gas, depending on its critical point (*see* page 145, Hydraulics I.), As a general rule, experiment shows that the further a gas is heated above its critical temperature of liquefaction, and at the same time the more highly rarefied a gas becomes, so that the particles of the gas have free play, and are, comparatively speaking, far apart, whilst the constant pressure is small, the more nearly does the gas follow this simple law.

Thus, when the pressure of a given quantity of gas is kept constantly at one atmosphere, we find that

	273	cubic feet	at 0° Cent.,
becomes	273 + 1	,,	at 1° Cent.,
,,	273 + 2	,,	at 2° Cent.,
,,	273 + 3	,,	at 3° Cent.,
and generally	273 + t	,,	at t° Cent.

The fraction $\frac{1}{273}$, or ·00367, is called the co-efficient of expansion of gases. The law of expansion under constant pressure may be expressed simply as follows:—

	1 cubic foot of gas at	0° Cent.,
becomes	1·00367 ,, ,, at	1° Cent.,
,,	1 + ·00367 × 2 cubic feet of gas at	2° Cent.,
,,	1 + ·00367 × 3 ,, ,, at	3° Cent.,
,,	1 + ·00367 × 20 ,, ,, at	20° Cent.
and generally	1 + ·00367 × t ,, ,, at	t° Cent.

Thus one cubic foot of gas at 0° Cent. becomes under constant pressure (1 + ·00367 × t) at t° Cent.; and since in v_o cubic feet of the same gas at 0° Cent. every cubic foot of it expands in this proportion, we shall find at t° Cent. under constant pressure the total volume equal to

$$v_o (1 + \cdot 00367 \times t).$$

Or the law of Charles for the expansion of a gas due to increase of temperature, under constant pressure, may be expressed in the more general form—

$$V_t = v_o (1 + a t), \quad . \quad . \quad . \quad (1)$$

where v_o stands for the volume of the given mass of gas at 0° Cent.,

V_t stands for the volume of the given mass of gas at t° Cent.,

and a stands for the *co-efficient of expansion*, meaning thereby *the change per unit volume, measured at 0° Cent., produced by 1° Cent. increase in temperature.*

In the case of dry air and many simple gases, for most practical applications we may take

$$a = \frac{1}{273} = \cdot 00367.$$

Then the above equation becomes

$$V_t = v_o \left(1 + \frac{1}{273} \times t\right),$$

or

$$V_t = v_o (1 + \cdot 00367 t).$$

It obviously follows that

$$V_{t_1} = v_o (1 + \cdot 00367 t_1),$$

where V_{t_1} stands for the volume of the same mass of gas under the same pressure at t_1° Cent.;

therefore we have by simple division

$$\frac{V_t}{V_{t_1}} = \frac{v_o (1 + \cdot 00367 t)}{v_o (1 + \cdot 00367 t_1)},$$

consequently

$$\frac{V_t}{V_{t_1}} = \frac{1 + \cdot 00367 t}{1 + \cdot 00367 t_1}. \quad . \quad . \quad . \quad (2)$$

Instead of decimals we may use vulgar fractions, and write the same equation

$$\frac{V_t}{V_{t_1}} = \frac{1 + \frac{1}{273}t}{1 + \frac{1}{273}t_1}$$

and, bringing the numerator and denominator on the right-hand side to a common denominator, 273, we have

$$\frac{V_t}{V_{t_1}} = \frac{273 + t}{273} \div \frac{273 + t_1}{273},$$

$$= \frac{273 + t}{273} \times \frac{273}{273 + t_1},$$

hence

$$\frac{V_t}{V_{t_1}} = \frac{273 + t}{273 + t_1} \qquad (3)$$

From this it is evident that, given the volume occupied by a quantity of gas at one temperature, we can readily calculate what its volume will be at another temperature, provided the pressure and quantity of stuff remain the same.

EXAMPLE 1.—A known weight of gas occupies 3 cubic feet at a temperature of 27° Cent., what will be its volume under the same pressure at 127° Cent?

Here let V_t stand for the volume at temperature 127° Cent.

and $V_{t_1} = 3$ cubic feet at temperature 27° Cent.

Substituting these values in the above equation (3), gives us at once

$$\frac{V_t}{3} = \frac{273 + 127}{273 + 27},$$

that is,

$$V_t = 3 \times \frac{400}{300},$$

$$V_t = 4 \text{ cubic feet.} \qquad \textit{Answer.}$$

DETERMINATION OF THE CO-EFFICIENT OF EXPANSION.

Instead of taking for granted that the co-efficient of expansion, $a, = \frac{1}{273} = \cdot 00367$, we may express the equation (2) in the more general form,

$$\frac{V_t}{V_{t_1}} = \frac{1 + at}{1 + at_1},$$

where a represents the mean value of the co-efficient of expansion at all temperatures intermediate to t and t_1.

This mean value of the co-efficient may be roughly and readily measured by means of the simple apparatus shown in Fig. 8. This consists of a glass bulb and tube, thoroughly cleansed and dried. Then dry air is introduced into the bulb, and enclosed by perfectly clean, pure mercury, which rises in the tube from a vessel containing it and exposed to the atmospheric pressure, which remains nearly constant throughout an experiment. This mercury vessel is supported on a shelf which can be raised or lowered, in order to adjust the mercury in the tube to atmospheric pressure. Part of the tube above the bend, as well as the large bulb, are com-

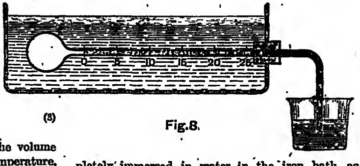


Fig. 8.

pletely immersed in water in the iron bath, as shown. Adjust the height of the mercury in the outside vessel so that the end of the mercurial column in the tube stands near the zero mark of the graduations when the water is cooled down as low as possible. The capacity of the bulb and tube up to this zero mark has been ascertained in terms of the divisions of the tube, so that the exact volume of dry air contained in the bulb and tube up to the mercurial column is known at any time. The temperature of the water in the bath is observed by means of a mercury thermometer immersed in the water alongside of and touching the large glass bulb, in order that its readings may give the temperature of the bulb and the air therein. On this account the water in the bath must be heated very slowly by means of gas burners below it, and at the same time kept well stirred, otherwise the temperature of the water will not be the same throughout the bath, and the temperature of the air in the bulb could not be accurately determined. It will be found that an appreciable interval of time elapses before the air in the bulb arrives at the temperature of the water in the bath—that is, the heat passes but slowly from the bath through the glass envelope to the interior of the mass of air contained therein.

Hence, in order to ensure that the air in the bulb is at the same temperature as that of the water in the bath, it is necessary, *before* taking a set of readings of the temperature and corresponding volume of the air, not only to stir the water well, but also endeavour, by adjusting the gas-jets underneath the bath, to keep the temperature of the water constant for a few minutes. When the temperature has become steady, observe simultaneously the position of the end of the mercury column in the tube and the temperature of the water in the bath.

Neglecting for the moment the expansion of the glass envelope, the volume of the air contained in the bulb and tube will in every case be found by adding the reading on tube to the capacity of the bulb and tube up to zero mark. Now gently warm the water in the bath, and so raise the temperature of the air gradually, causing the air to expand, and take simultaneous readings of temperature and volume, until the air in the tube has pushed back the mercury at constant pressure to the point marked 25. Next allow the bath to *cool gradually*, and take, as before, simultaneous readings of the temperature of the water and the volume of the air. Special precautions must again be taken by stirring the water in the bath, and regu lating the gas-jets to keep the temperature constant during each short interval immediately before taking the readings. On this account the gas-jets must not be turned completely out whilst the temperature of the water in the bath is high, else the water will cool so rapidly that its temperature will be appreciably less than that of the air in the bulb.

An example will serve to explain the calculations by which the co-efficient of expansion of a gas under constant pressure may be deduced from the observations made from such an experiment.

The capacity of the bulb and tube up to the commencement of the graduations is found to be equal to 57·36 divisions of the tube.

The results of experiment are tabulated as follows :—

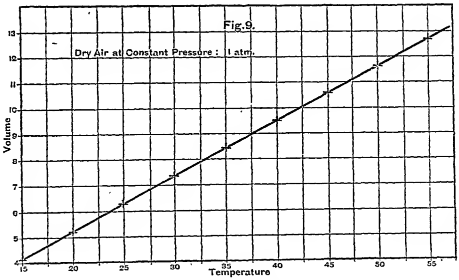
DRY AIR AT CONSTANT ATMOSPHERIC PRESSURE.

perature of er in bath, t° Cent.	Position of end of mercurial column, n divisions.	Total volume of air. $v = (57·36 + n)$ divisions.
15°	4·14	61·50
20°	5·20	62·56
25°	6·25	63·61
30°	7·35	64·71
35°	8·40	65·76
40°	9 50	66·86
45°	10·50	67·86
50°	11 60	68·96
55°	12·62	70 00

Take a sheet of squared paper, and plot a curve having for vertical heights the values of v, the volume of air, and for horizontal distances the corresponding temperatures, t, as in Fig. 9.

We may reduce the size of the sheet of squared paper required by taking vertical distances to represent the divisions, n, of the tube, to which, we must bear in mind, 57·36 has to be added to give the total volume of the air.

For convenience in size of squared paper, the temperature may only be plotted above 15° Cent., as shown in Fig. 9. The points obtained in this way as the result of experiment are found to be very fairly in a straight line, some being on either side of this line, which passes evenly among the points, thereby corrects slight errors of observation, and gives the exact relation between the volume and temperature of the dry air heated under constant pressure. Had there been any



serious error made in taking some of the readings, these points would not have agreed so closely with the line passing evenly through the others.

We can now calculate the co-efficient of expansion of the air from any two points on this line (Fig. 9), which shows the result of a pair of experiments. Suppose, for instance, we take the volumes of the air corresponding to the temperatures 20° Cent. and 50° Cent.

Then the above equation,

$$\frac{V_t}{V_{t_1}} = \frac{1 + at}{1 + at_1}$$

becomes

$$\frac{57 \cdot 36 + 5 \cdot 2}{57 \cdot 36 + 11 \cdot 6} = \frac{1 + a \times 20}{1 + a \times 50};$$

that is,

$$\frac{62 \cdot 56}{68 \cdot 96} = \frac{1 + 20a}{1 + 50a},$$

hence $62 \cdot 56 + 3128a = 68 \cdot 96 + 1379 \cdot 2a$,

$$\frac{1379 \cdot 2a}{1748 \cdot 8a} = \frac{62 \cdot 56}{6 \cdot 4},$$

therefore

$$a = \frac{6 \cdot 4}{1748 \cdot 8} = \cdot 003659.$$

This is the apparent mean co-efficient of the expansion of the air when enclosed in glass. But the glass of the bulb and tube also expands. hence the co-efficient of expansion of glass, which may be taken as 0·000026, must be added to ·003659 to obtain the absolute mean co-efficient of expansion of the air within the given range of temperature.

This works out to ·00368, a very close approximation to the exact result, ·00367, obtained by elaborate experiments with more delicate apparatus. Our co-efficient being too high, indicates that the air under consideration was not perfectly dry, since any moisture or vapour of water present in it would increase more rapidly in pressure than air when heated.

Again, Regnault's results show that the mean co-efficient of expansion of air between 0° and 100° Cent. increases with the constant pressure to which the air is subjected whilst being heated. Thus, when a given mass of dry air under a constant pressure of 1 atmosphere is heated, the ratio of the volumes at 0° and 100° Cent. is 1·36706; but when the same mass of air is heated under a pressure of 3·447 atmospheres, the ratio of the volumes at 0° and 100° Cent. is found to be 1·36964; in other words, the mean co-efficient of expansion becomes ·003694 when the constant pressure is 3·447 atmospheres.

In the case of hydrogen gas, this co-efficient is ·0036613 under a constant pressure of 1 atmosphere, and ·0036616 at a pressure of 3·349 atmospheres. On the other hand, the same co-efficient for carbonic acid increases from ·003709 to ·0038455 when the pressure is changed from 1 to 3·316 atmospheres.

The co-efficient of expansion per degree Fahr. is $\frac{5}{9}$ of the co-efficient per degree Cent., the expansions being reckoned from 32° Fahr., the freezing-point of water.

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